Independent Assessment of Space Shuttle Ground Operations Processing Capability

Workforce Survey - Kennedy Space Center
April 30 – May 2, 2001

Office of Safety & Mission Assurance
Independent Assessment Team
October 31, 2001

Executive Summary

Background

In July of 1998 NASA Administrator Daniel Goldin called for a review to "independently assess the readiness of both United Space Alliance (USA) and the NASA flight-critical processes to safely accommodate the increased flight rate at current staffing levels and skill mix." The original assessment was initiated in response to staff reductions occurring in the USA workforce between January and July of 1998. A follow-up study was completed in April 1999. The present study represents the last in this series of studies, each separate and distinct in focus and objective, but all related in that each addressed specific aspects of the United Space Alliance Ground Operations (USAGO) workforce capability during a time of change in processes, workforce composition, and manifest demands. Each of these studies was conducted by the Office of Safety and Mission Assurance (OSMA) Independent Assessment Team (IAT).

The primary objective of the present study was to evaluate and assess the overall USAGO workforce capability, specifically with respect to workforce satisfaction and attitudes toward safety and workplace stress under a four-orbiter-in-flow condition. A second related objective was to assess the value and usefulness of current work time deviation (WTD) metrics as a measure of overtime in monitoring and managing individual and aggregate workforce stress and fatigue.

Methodology

The method chosen to accomplish these objectives was to administer a survey questionnaire through one-on-one interviews with selected individuals from the ground operations workforce. The IAT operated from the underlying premise that there exists a general cause and effect relationship between Shuttle operational safety and workforce stress and, hence, the principle questions in the survey were formulated on this basis. Specifically, seven of the 11 survey questions logically correlate to both workplace safety and workplace stress.

It should be noted that the OSMA survey shares many common design features with the Lord and Hogan "Stress and Safety Study" conducted for United Space Alliance in February 2000. This study examined issues of job stress, work related safety, and other issues relevant to United Space Alliance in general. The Lord and Hogan study and the present OSMA survey both address similar components of occupational stress including "role overload " and "role insufficiency," identified by Lord and Hogan as the two primary occupational stressors, as well as "role ambiguity" and "role boundary" occupational stressors. It should be further noted that the principle findings presented in this report are consistent with those of the Lord and Hogan study.

The survey questionnaire was reviewed and modified based on input by the Space Shuttle Program (SSP), USAGO, OSMA, as well as NASA Ames Research Center and the NASA Goddard Space Flight Center human factors experts and deemed sufficient to

provide useful information for NASA management. The quantitative analysis of binary and Likert-scale data (seven stress and safety-correlated questions) coupled with the qualitative evaluation of 958 individual narrative responses acquired in 36 hours of one-on-one interviews provides the basis for the findings and recommendations.

Findings

- Under the sampling conditions (survey population, four orbiter in-flow, skill mix, staffing levels, experience level, etc.) and recognizing inherent sampling error and questionnaire limitations, the IAT finds that overall workplace induced stress does not appear to be a present safety concern. Based on the results of this assessment and the two previous assessments of USAGO workforce capability, the IAT reaffirms the previous finding that USAGO has established the capability to safely accomplish an evenly spaced flight rate of up to seven flights per year.
- Under the given sampling conditions the data indicates a slightly negative correlation between workplace-induced stress and work time deviations, i.e., overtime. This lack of an expected strong positive correlation (i.e., high levels of stress associated with high numbers of work time deviations) may have several explanations:
  - A moderate level of overtime work is expected and welcomed as it allows the workforce to remain focused, on-task, and energized with "motivational stress." This would appear to be consistent with the findings of Swain and Guttmann (see figure 4.2) which indicates that there exists some optimum or "minimal" level of task loading and attendant stress that maximizes performance effectiveness.
  - Self-elected overtime represents a positive income supplement and provides individuals with increased flexibility in personal financial matters thereby reducing overall life-stress. As a correlate, individuals with high WTD's may have deliberately or unconsciously assessed a lower level of workforce stress so as not to jeopardize future access to overtime work and the increased income derived therein.
  - Work time deviation metrics as currently defined and applied have not observed (can not observe?) that range of overtime that could potentially result in stress and/or fatigue levels, i.e., the far right portion of the Swain-Guttmann curve, sufficient to jeopardize safe Space Shuttle operations.
- Many workers note transient periods of high stress.
- First line supervisor subgroup reports higher stress levels on average than the technician or non-supervisor workforce.
- Scheduling changes drive stress.
- Late arriving parts (locally ordered as well as GFE from JSC) and paper (both internally and externally generated) drive stress at KSC.
- Delays, starts and stops drive stress.
- Skill-mix and training/certification imbalance imposes greater demands and stress on fully qualified (Level-1) workforce.

- Reported unsafe activities and/or conditions - a number of the individuals interviewed reported knowledge of unsafe activities or conditions in Space Shuttle ground operations (see 4.1.3 and appendix C).

Recommendations

The following recommendations are offered to assist KSC SSP ground processing in moving toward these goals:

1. NASA KSC SSP management should commit to conducting independent workforce surveys on a periodic (e.g., semi-annual) basis. While the current survey represents only a snapshot in time it could serve as the starting point for periodic surveys that track workforce attitudes and perspectives regarding workplace satisfaction and safety. Future survey planning should consider sampling that includes all members of the workforce (including those individuals with zero WTD) as well as a wide range of questions addressing workplace factors that are recognized correlates to occupational safety and stress.

2. NASA KSC should continue to evaluate the KSC maximum work time deviation policy (as part of a broader NASA WTD policy assessment) to determine if changes are warranted. This reevaluation should:
   - consider the ability to measure/monitor stress and fatigue levels over the entire range of work load/overtime conditions (as shown in figure 4.2) including both high stress/high task loading as well as low stress/low task loading operational regimes.
   - evaluate the need for WTD rules to limit initiation of hazardous or critical operations in the late hours of an extended shift (e.g., beginning a hazardous operation on hour eleven of an individual's shift) or conducting critical operations in the early morning hours.
   - evaluate the implications of "double counting" as noted in section 2.2.

3. NASA KSC SSP and USAGO management should address and develop solutions for late paper and parts from both internal sources and external SSP elements.

4. USAGO should consider and evaluate the need for increased training opportunities for the 2nd shift work force and increased training opportunities in new technology areas.

5. USAGO should continue to assess and manage skill mix/training issues to more effectively and safely meet workload demands. The IAT recommends that the NASA/USA refine and implement the Workforce Flexibility Model as a viable means to address skill mix, numbers, and training/certification imbalances.

6. NASA KSC SSP and USA should continue current efforts that reinforce the critical importance of the timeout policy for all levels of the work force (management, engineering, technician, administrative) and the goal of 100% acceptance.

7. USA Management should undertake efforts to better inform and educate the touch-labor work force regarding the purpose, value, and application of metrics, in general, and the WTD metrics, in particular.

8. NASA KSC SSP and USA management must redouble their efforts to improve workforce understanding and acceptance of Structured Surveillance as an important and necessary safety control process. The idea of structured surveillance as a means to maintain stable, capable, and controlled critical processes remains an excellent and essential concept for implementing checks and balances within the scope of a performance based contract.

9. NASA KSC SSP and USA should address each of the issues reported in section 4.1.3, validate their accuracy, and establish corrective action when validated.

Dedication

This report is dedicated to Mr. Claude S. Smith, a charter and now emeritus member of the NASA Office of Safety and Mission Assurance Independent Assessment Team.

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1.0 Introduction

1.1 Overall Objective

This study represents the third in a series of reviews of Space Shuttle ground operations that have been conducted over the past three years by the Independent Assessment Team (IAT) established by the Office of Safety and Mission Assurance (OSMA). The overarching purpose of this series of independent assessments was to assure continued Space Shuttle operational safety during a time of change in processes, workforce composition, and manifest demands.

The primary objective of the present study was to evaluate and assess the overall United Space Alliance Ground Operations (USAGO) workforce capability, specifically with respect to workforce satisfaction and attitudes toward safety and workplace stress under a four-orbiter-in-flow condition. A second related objective was to assess the value and usefulness of current work time deviation (WTD) metrics as a measure of overtime in monitoring and managing individual and aggregate workforce stress and fatigue.

1.2 Background

While the independent assessments in this series are broadly related to the issue of USAGO workforce capability, each represents a stand-alone assessment having its own theme, focus, and specific objective. The first of the reviews, completed in October of 1998, was initiated in response to staff reductions, specifically a reduction of 552 full-time employees in the USAGO workforce, that occurred between January and July of 1998. The review assessed the readiness of both the United Space Alliance (USA) and NASA flight-critical ground processes to safely accommodate an increased flight rate given the changes in staffing levels and skill mix. In this first review, the IAT focused on the design and implementation of work control, work review, and change control processes employed in ground operations.

A follow-on to the initial study was completed in April of 1999. The purpose of this second review was to determine whether proposed USA process improvements, referred to as "Strategic Initiatives," would provide the efficiencies necessary to compensate for workforce reductions, thereby providing the capability to support increased manifest demands that were expected in late (CY) 1999. (A brief review of the principal objectives and findings of these two studies is provided in appendix A of this report.) Based on these reviews, the IAT concluded that the Space Shuttle ground operations processes (work control, work review, change control) were sufficiently robust in design and staffing (in terms of numbers and skill mix) so as to preclude, to the greatest extent possible, in-flight anomalies attributable to ground processing activities.

However, even excellent processes that are appropriately staffed and supported can be vulnerable to failure under extreme or unusually stressful conditions. Excessive loading of these processes - comprised of information management systems, hardware, software

and, most importantly, people - can diminish process capability and increase the likelihood or potential risk of a Shuttle processing safety escape. In addition, less experienced workers under conditions of intense schedule pressure may be more vulnerable to making errors and/or perceiving schedule as the overriding priority.

Thus, the specific objective of this third assessment was to verify that the in-place ground operation processes remain stable, capable, and in control under maximum workload conditions as represented by the four-orbiter-in-flow work environment. This was accomplished by examining specific workplace stress factors and the use of work time deviations as a principal management tool and metric to monitor workforce stress and fatigue.

2.0 Approach

2.1 Hypothesis and General Assumptions

The first assumption under which this independent assessment was conducted was that Space Shuttle operational safety is related to process capability (see figure 2.1, link 3). Process capability is comprised of a multiplicity of factors including staffing levels, process design, process controls, process management and process stability. Key process capability issues, namely process design and staffing, were examined in the NASA Headquarters/OSMA reviews conducted in 1998 and 1999. One issue not explicitly addressed in these previous studies was the important human performance capability element.

Human performance capability is addressed in terms of human reliability by Swain and Guttmann in their seminal 1983 work, "The Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications" (see references), prepared for the Nuclear Regulatory Commission.

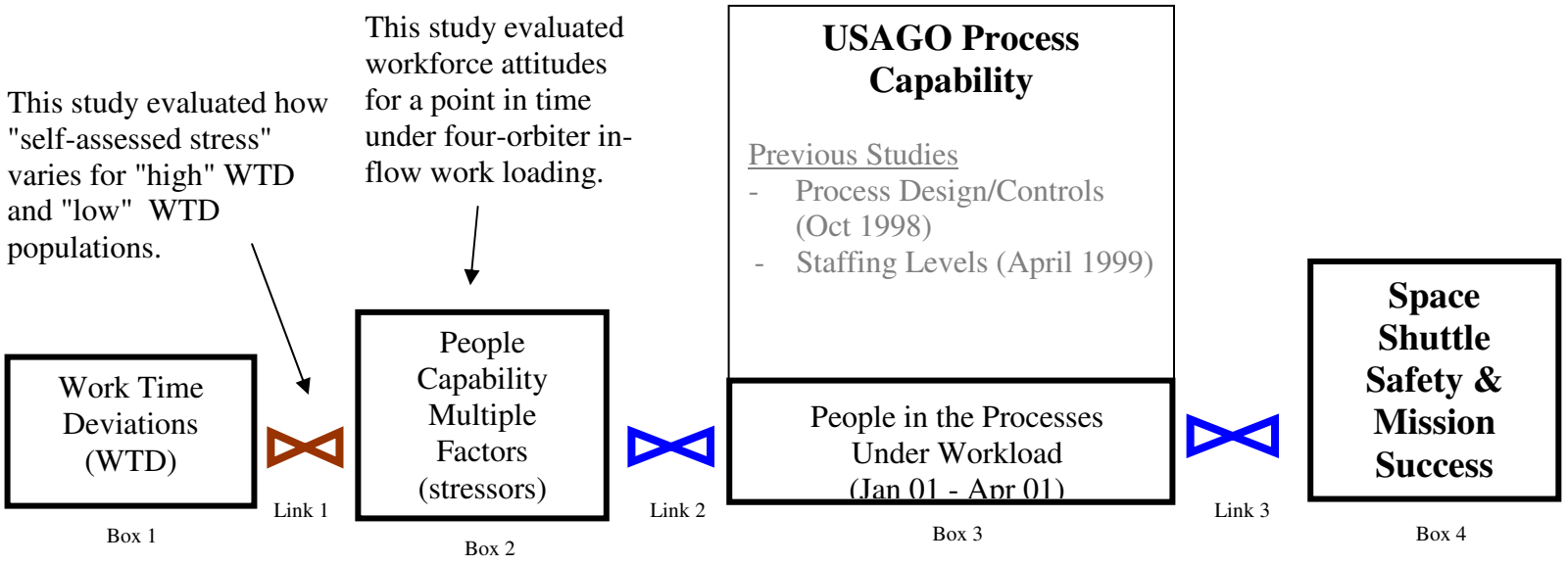
The authors suggest a framework, in which humans can be considered components of complex systems performing critical functions essential to the system, with multiple complex interfaces both internal and external. They identified performance shaping factors (PSF) which include those elements external to the individual (situational characteristics such as overtime, facilities, tools, equipment, work instructions, etc.) as well as internal elements directly associated with individual capability such as training, education, skills, and experience. The model also introduced the notion of stressors that represent physical and psychological factors that operate along with the external PSF's to influence human error probabilities ultimately used in nuclear power plant probabilistic risk analysis. Task loading was identified as one of the key psychological stressors in the framework.

A second assumption, shown as link 2 in figure 2.1, indicates the relationship between capable people (box 2) and capable processes (box 3). The third assumption, shown in figure 2.1 as link 1, reflects the general relationship between WTD's (one measure of fatigue) and human capability. This relationship is characterized in Swain and Guttmann,

as well as KHB 1710.2, Rev. D, "Kennedy Space Center Safety Practices Handbook" and USA Operating Procedure USA003343.

A further assumption was made that "ground operations", as defined for the purposes of this assessment, would include only horizontal, vertical, and ground support (i.e., transporter, pad, etc.) processing activities. Obviously this does not include all of the activities and processes that collectively constitute the totality of USA Space Shuttle ground operations. However, the IAT, jointly with KSC and USA management, determined that this definition of ground operations encompasses those critical work areas and activities that affect and, in turn, are most affected by manifest or schedule pressures and, therefore, involves the greatest operational safety implications.

Figure 2.1 Assumed Dependencies and Historical Context



2.2 Work Time Deviation Metrics

The NASA and USA policies that govern the development and application of work time deviation metrics are described in the following two sections. The IAT did not conduct a verification or review of the actual implementation of these policies.

2.2.1 Policy

Central to this assessment is a proper understanding of the definition and application of WTD metrics currently employed by USAGO. These metrics trace their heritage to the Rogers Commission ,"Report of the Presidential Commission on the Space Shuttle Challenger Accident" (see references), where human factors, including workload demands, shiftwork, and the relationship of overtime and safety, were addressed.

Building upon this heritage, the maximum work time policy for Space Shuttle operations is defined and described in KHB 1710.2, Rev. D, "Kennedy Space Center Safety Practices Handbook." The stated intention is to "… minimize the probability that mishaps will occur because personnel in critical positions work excessive hours." Specifically, the KHB outlines provisions such that persons in critical positions:

- Shall not work in excess of;
  - 12 consecutive hours (maximum of 16 hours when a one-time job circumstance exists)
  - 60 hours in any one work week
  - 240 hours per four week period
  - 2500 hours per year

- Shall be allotted a minimum of 8 hours off between workdays

- Shall work no more than 7 consecutive days without one full day off

Based on these provisions, NASA and USA have developed and are using the following specific work time deviation metrics:

- > 12 hours/day
- > 16 hours/day
- < 8 hours time off between shifts or workdays
- > 7 consecutive days worked
- > 60 hours/week
- > 240 hours/28 day or four week period

These metrics were used during this assessment as the basis for determining what correlation, if any, exists between work time deviations and work force stress levels (see section 4.3). It should be noted that the metrics, as currently defined, are not mutually exclusive nor separate and distinct in their application. For example, it is clear that if an individual qualified for a work time deviation of > 16 hours/day, he/she must necessarily

be identified as having exceeded the > 12 hours/day metric as well. Thus, there would be two deviations assigned to this one individual for a single overtime incident. Likewise, if an individual were to exceed the 60 hours/week criteria for four weeks in a row he/she would also qualify for exceeding the > 240 hour/four week period as well. Therefore, in the current application, this is counted as five work time deviations (four > 60 hours/week plus one >240 hour/four week period). The impact and potential implications of this "double counting" will be addressed in the recommendation section of the report.

2.2.2 Implementation

USA Operating Procedure USA003343 has been developed to implement the KHB work time deviation policy. This operating procedure requires (among other things) that first-line (or higher) managers:

a. Identify potential maximum work time deviation requirements as far in advance as possible.

b. Assess the suitability of an employee's working beyond maximum work time requirements and remain vigilant for signs of employee fatigue.

3.0 Independent Assessment Methodology

3.1 Overview

The primary objective of this assessment was to evaluate overall workforce satisfaction and attitudes, as related to both ground and flight safety and workplace stress, experienced by the USAGO workforce during a period of high workload (i.e., four-orbiter-in-flow). A second objective was to assess the value and usefulness of the current WTD metrics in monitoring individual and aggregate stress levels. The method chosen to accomplish these objectives was to construct a survey questionnaire for use during one-on-one interviews with a sampling of individuals from the ground operations workforce.

A key objective in constructing the questionnaire and conducting interviews was to statistically test the hypothesis that, on a collective basis, high numbers of work time deviations would correspond to high levels of stress and low numbers of work time deviations would indicate relatively low levels of workforce stress. Consequently, the overall sample was divided into two groups or subsets, those individuals with "high" numbers of work time deviations and those with relatively "low" numbers of work time deviations. The distinction between "high" and "low" was established by the IAT to be greater than or equal to 4 work time deviations in the former case and less than or equal to 3 work time deviations in the latter case. This arbitrary division was discussed with USA management and deemed to be a fair and reasonable way to characterize the "high" and "low" work time deviation populations contained within the ground operations workforce.

The workforce sample to be interviewed included touch-labor (non-supervisory) and first-line supervisors from the horizontal processing, vertical processing, and ground support service directorates. All work time deviation data analyzed and used in this review were recorded from January 1 to April 15, 2001, which met the requirement for a high workload (i.e., four-orbiter-in-flow) condition for the USAGO workforce deployed during this time period.

3.2 Questionnaire

The IAT, with input and comment from USA ground operations management, developed a questionnaire designed to assess the general attitude, overall satisfaction, and level of stress associated with current ground operations working conditions and environment. (A sample of the questionnaire is provided in appendix B.) The overall scope and structure of the survey can best be characterized and understood by the three general types of responses required:

1) Narrative responses concerning the overall safety of work areas, tasks, and duties, and the individual's awareness and use of metrics (questions 1, 2, 3, and 10).
2) Binary-type (primarily yes or no) responses regarding the availability of training/training opportunities, receiving timely direction, having clear and correct work instructions, the sufficiency of checks and balances, and the ability to call safety "timeouts" (questions 4 through 9).
3) Numerical responses on a Likert-type scale (see references) to assess individual stress levels
(question 11).

The IAT operated from the underlying premise that there exists a general cause and effect relationship between Shuttle operational safety and workforce stress (see section 2.1) and, thus, the questions in the survey were primarily formulated on this basis. Seven of the eleven questions (specifically groups 2 and 3 as defined above) logically correlate to both workplace safety and workplace stress.

Additionally, the OSMA questionnaire was similar in design to the February 2000 Lord and Hogan study in that it addressed similar components of occupational stress including “role overload" and "role insufficiency," identified by Lord and Hogan as the two primary occupational stressors. The OSMA survey also addressed issues related to the “role ambiguity” and “role boundary” stressors defined in the Lord and Hogan study.

The survey questionnaire was reviewed and modified based on input by Space Shuttle Program (SSP), USAGO, OSMA, as well as NASA Ames Research Center and the NASA Goddard Space Flight Center human factors experts and deemed sufficient to provide useful information for NASA management.

Note: Workforce safety surveys, particularly for complex, tightly coupled, high technology industries, are routinely conducted as a proactive bottom-up approach to

assure ongoing safety as well as process stability and capability. The advantages of this approach include active involvement of the workforce in safety management, more effective allocation of safety resources, and better communication between management and staff. Several widely employed approaches have been derived from the work of James Reason at the University of Manchester in the United Kingdom (see references). Examples include the Managing Engineering Safety & Health (MESH) workplace survey methodology designed to sample the safety health of aircraft maintenance organizations. MESH is derived from the Tripod-Delta model, developed by James Reason and Shell International for tanker exploration and production operations. All of the methodologies involve conducting periodic surveys of employee attitudes regarding local workplace factors and higher-level organizational factors.

3.3 Survey Interviews

The IAT, comprised of four individuals (see section 3.5), conducted the individual interviews on April 30 and May 1, 2001, with selected USAGO personnel. Each team member, using the survey instrument described above, conducted one-on-one interviews with 18 individuals. Each interview typically required 20 to 30 minutes. The sessions spanned two working days and provided a total sample of 72 interviews. The demographics for the total sample of 72 are as follows:

- Samples drawn from the workforce populations in horizontal processing (Orbiter Operations), vertical processing (Launch Operations), and ground support services (GSS).

- High work time deviation sample - 36 total: ten touch-labor (non-supervisory) plus two supervisors from each area.

- Low work time deviation sample - 36 total: ten touch-labor (non-supervisory) plus two supervisors from each area.

While not strictly adhering to conventional or standard "double blind" test conditions, each of the 72 individuals interviewed was given an identification number and randomly assigned to one of the four IAT interviewers. Therefore, at the time the interviews were conducted, and with the intent of minimizing any real or perceived biases, the interviewer was not cognizant of the individual's personal identity, his or her work area, whether he/she was a supervisor, or whether the individual was from the high or low work time deviation sample. The individual questionnaire responses are provided in appendix C. (It should be noted that the “reference numbers” in appendix C were randomly assigned to assure anonymity for the individual participants during analysis and any subsequent implementation of the survey results.)

3.4 Data Reduction and Analysis

The raw data and information contained in the individual questionnaires were entered into a fully relational database to facilitate data reduction and analysis. Given the amount

of data available and the numerous possibilities for comparative analysis, extensive deliberations of the IAT determined that the following data "cut sets" and summary information would provide the most useful perspectives.

- Comparison and correlation of computed mean stress levels by:
  - Work area
  - Supervisor vs. non-supervisor (overall)
  - Supervisor vs. non-supervisor within each work area
  - High vs. low work time deviations (overall)
  - High vs. low work time deviations within each work area
- Statistical inference analyses to establish the level of significance for the comparison/correlation of population means:
  - Small sample (Student's t distribution) analysis
  - Large sample test of hypotheses
- Individual summaries of each question providing:
  - Key findings and observations for both the narrative-based and binary form questions
  - Percentages of yes and no responses for the binary form questions

Details of the specific data analyses, comparisons, and summary narratives are provided in section 4.0 - "Survey Analyses and Results."

3.5 Independent Assessment Team

The IAT was comprised of the following members:

- J. Steven Newman (Lead) - Office of Safety and Mission Assurance
- Stephen M. Wander - Office of Safety and Mission Assurance
- John P. Castellano - Office of Space Flight
- William C. Hill - Office of Safety and Mission Assurance *
- Pamela F. Richardson - Office of Safety and Mission Assurance *

*Mr. Hill participated in the early study formulation process and planning meetings but was unavailable to participate in the conduct of the on-site interviews. Ms. Richardson substituted for Mr. Hill during the interview process. Both participated in the subsequent data reduction, analysis, and report preparation.

4.0 Survey Analyses and Results

This section provides summary results for each of the survey questions. Accordingly, section 4.1 discusses the results for those questions requiring only a narrative response, section 4.2 summarizes results for the binary (yes/no) type questions, and section 4.3 presents the numerical results for the stress level question. This last section includes an analysis and discussion of the overall workforce stress level and an assessment of the correlation between work time deviation metrics and the self-assessed stress levels. This section also contains a description of the statistical analyses undertaken to assign a level of significance to the computed correlation among the selected subgroups in the data set.

4.1 Narrative Questions

4.1.1 Question 1 - "What could go wrong with your process that could result in unsafe Shuttle operations?"

This question, not unexpectedly, solicited a wide variety of responses ranging from essentially no response to detailed descriptions of work activities and processes associated with the individual's specific job duties. However, the IAT observed that a majority of individuals (approximately 65%) were aware of things that could go wrong with their work process(es) and that could potentially have an adverse effect on Shuttle safety. General categories cited most often included: 1) deviation from work instructions or improper work instructions; 2) communication issues; 3) working under time/schedule pressure; and 4) handling and servicing hazardous and/or toxic materials. It must also be noted that eight individuals (11% of the total population) responded simply “nothing,” or “nothing can go wrong.” Another group of individuals did not provide relevant responses to the question of Shuttle safety.

4.1.2 Question 2 - "What metrics (if any) are being used to monitor your work process?"

Question 3 - "What metrics could be/should be used to more effectively monitor your work process?"

These two questions also produced extremely varied responses that were initially perceived as not measurably contributing to the purpose or intent of this study. However, upon reflection, the very nature of these eclectic responses suggests that the USAGO workforce, particularly the touch-labor or non-supervisory personnel, appear to have a significant lack of understanding regarding the concept, application, and utility of management metrics. (See appendix C for the complete list of responses.)

In particular, responses to Question 2 included 16 volunteered references to the current structured surveillance activities. Seven of the responses (four supervisors and three non-supervisors) were neutral (reference numbers: 84, 31, 55, 34, 46, 33, and 44) while nine (one supervisor and eight non-supervisors) were negative (reference numbers: 53, 26, 70, 91, 85, 81, 90, 69, and 32). Negative comments noted the adversarial nature of the

implementation, lack of real time feedback, lack of understanding, and several cases called into question the overall value of the activity. These results further substantiate the need for expanded efforts to foster a wider understanding of the purpose and importance (personal and programmatic) of safety and assurance surveillance activities.

4.1.3 Question 10 - "Are there activities or conditions in other areas that you know about that are unsafe or could lead to an unsafe condition?"

The IAT fully recognizes that responses to question 10 represent single observational data points. However, the team also believes that the responses provide USA and SSP management with a unique bottoms-up view of issues of concern to individual workers. While it is beyond the scope of this review to expand the analysis of each comment and document the resolution or corrective action, there is real value embedded in the sharing of potential safety concerns and issues. The specific responses identified below (excerpted from appendix C) were deemed to be directly related to safety and, thus, worthy of special note and consideration:

- Suggestion of using a hoisted system for removal and installation of the Star Tracker door while in the OPF. (Present method is to manually perform this operation.)

- During launch operations workers go on a two-shift operation with the day shift starting at 3:00am. This early shift start may be incompatible with the body's bio-rhythm with workers still in a state of sleep mode. (It was suggested that the start of the 2nd shift be closer to a "normal" wake up time.)

- During operations in the OPF, hazardous operations (e.g., venting hypergols) are performed in parallel with lifting operations.

- Working in the Orbiter mid-body, limited protection is provided for flight hardware tubing. Damage potential was assessed as very high.

- Paint chips and rusted metal flecks from launch pad and mobile launch platform structures provide a debris danger to the Space Shuttle orbiter aft-end if ingested into the recirculating launch plume pressure eddies.

- Unsafe conditions existed during a nighttime March 2001 orbiter/shuttle carrier aircraft mating operation at Dryden Flight Research Center involving harsh environmental conditions, schedule pressure, and a fatigued workforce.

- Pad facility maintenance group (GSS) on Pad A was reported as not following the proper safety discipline. Specific examples provided were:
  1) an untethered wrench at the 195 ft level fell to 120 level and; 2) a technician installing a clamp on a water line at level 208 (ET/IT) hanging over a rail without a safety harness. (These instances were reported by two individuals in separate interviews.)

4.2 Binary Questions

4.2.1 Question 4: - "Do you feel you have sufficient time to complete your assignment(s) safely?"

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	61	**85**	11	**15**
Supervisors	12	all	8	**67**	4	**33**
Non-supervisors	60	all	53	**88**	7	**12**
Horizontal Processing (All)	24	51000	16	**66**	8	**34**
Supervisors	4		2	**50**	2	**50**
Non-supervisors	20		14	**70**	6	**30**
Vertical Processing (All)	24	53000	23	**96**	1	**4**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	22	**91**	2	**9**
Supervisors	4		2	**50**	2	**50**
Non-supervisors	20		20	**100**	0	**0**

Table 4.1

4.2.2 Question 5 - "Do you feel you have sufficient training/training opportunities/certification to safely accomplish your job duties?"

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	64	**89**	8	**11**
Supervisors	12	all	10	**83**	2	**17**
Non-supervisors	60	all	54	**90**	6	**10**
Horizontal Processing (All)	24	51000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**
Vertical Processing (All)	24	53000	22	**91**	2	**9**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		18	**90**	2	**10**
Ground Support (All)	24	56000	20	**83**	1	**17**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		17	**85**	3	**15**

Table 4.2

4.2.3 Question 6 - "Do you feel you receive timely direction and proper inputs (paper/parts/etc.) to accomplish your job duties safely?"

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	57	**80**	15	**20**
Supervisors	12	all	9	**75**	3	**25**
Non-supervisors	60	all	48	**80**	12	**20**
Horizontal Processing (All)	24	51000	20	**83**	4	**17**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		16	**80**	4	**20**
Vertical Processing (All)	24	53000	16	**67**	8	**33**
Supervisors	4		1	**25**	3	**75**
Non-supervisors	20		15	**75**	5	**25**
Ground Support (All)	24	56000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**

Table 4.3

4.2.4 Question 7 - "Do you feel you receive clear and correct work instructions to accomplish your job duties safely?"

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	63	**88**	9	**12**
Supervisors	12	all	11	**91**	1	**9**
Non-supervisors	60	all	52	**87**	8	**13**
Horizontal Processing (All)	24	51000	20	**83**	4	**17**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		16	**80**	4	**20**
Vertical Processing (All)	24	53000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**

Table 4.4

4.2.5 Question 8 - "Does your work process(es) have sufficient checks and balances (e.g., inspections) to preclude unsafe operations? If so what are they? If not what would you suggest (e.g., an 'extra pair of eyes', an additional inspection point, etc.)."

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	67	**93**	5	**7**
Supervisors	12	all	11	**92**	1	**8**
Non-supervisors	60	all	56	**93**	4	**7**
Horizontal Processing (All)	24	51000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**
Vertical Processing (All)	24	53000	24	**100**	0	**0**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		20	**100**	0	**0**
Ground Support (All)	24	56000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**

Table 4.5

4.2.6 Question 9 - "Do you feel it's OK to call a 'timeout' when you see safety violations or unsafe behaviors without fear of adverse action? (Is the policy clearly defined? Is it clear to you when to use it?)"

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	67	**93**	5	**7**
Supervisors	12	all	12	**100**	0	**0**
Non-supervisors	60	all	55	**92**	5	**8**
Horizontal Processing (All)	24	51000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**
Vertical Processing (All)	24	53000	23	**96**	1	**4**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	23	**96**	1	**5**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**

Table 4.6

4.3 Self-Assessed Stress Level Results

4.3.1 Overall Stress Levels

Each individual interviewed was asked to provide a self-assessment of the personal level of stress associated with the performance of his/her specific job duties and functions. A Likert-type scale was defined and used by the IAT to assess the overall workforce stress level. The stress scale is defined below:

- Level 1 - None
- Level 2 - Low
- Level 3 - Average
- Level 4 - Moderate
- Level 5 - High

Table 4.7 summarizes the stress level data by work area and supervisor vs. non-supervisor subgroups.

Self-Assessed Stress Level								
	All Org Codes		**Supervisors**			**Non-supervisors**		
	Sup	**NonSup**	**Horiz**	**Vert**	**GSS**	**Horiz**	**Vert**	**GSS**
Average	**3.2**	**2.4**	**3.6**	**2.5**	**3.5**	**3.1**	**2.2**	**1.8**
Sample	12.0	60.0	4.0	4.0	4.0	20.0	20.0	20.0
Std. Dev.	1.3	1.0	0.5	1.3	1.9	0.9	0.9	0.7
Variance	1.8	1.0	0.2	1.7	3.7	0.8	0.9	0.5

Table 4.7 Self-Assessed Stress Levels

While detailed findings and recommendations are provided in section 5.0, a quick examination of the data in table 4.7 reveals several important observations worth noting:

- The overall level of stress for the USAGO workforce does not appear to be a problem for the four-orbiter-in-flow condition.
- First line supervisor subgroup reports higher stress levels on average than the technician or non-supervisor workforce.

4.3.2 Comparison of Work Time Deviation (WTD) vs. Stress Level

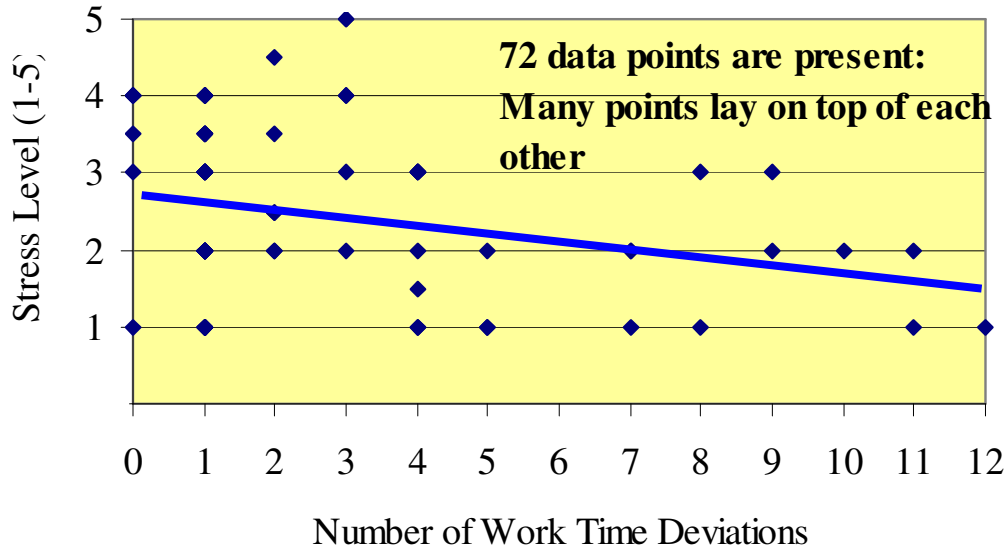
Table 4.8 provides the computed average or mean for work time deviations and self-assessed stress levels and a comparison of these data between the high work time deviation (four or more work time deviations) sample and the low work time deviation (three or less work time deviations) sample.

	High WTD Sample		**Low WTD Sample**	
	WTD	**Stress**	**WTD**	**Stress**
Sample Size (n)	22	22	50	50
Average	6.64	**1.89**	1.24	**2.77**
Std. Dev.	2.74	0.82	0.82	1.11

Table 4.8 Comparison of Work Time Deviation vs. Stress Level

This data indicates that there exists an inverse or negative correlation between the high and low work time deviation samples with respect to the average self-assessed stress levels. This is graphically displayed in the form of a linear regression and correlation analysis depicted in figure 4.1.

Figure 4.1 Self Assessed Stress versus WTD



The derived linear regression equation is: Stress = -.1118 * WTD + 2.82. Error bounds on the line of regression have not been developed, nonetheless it is clear that over the range and type of WTD's evaluated the slope is either weakly negative or possibly flat, indicating minimal or no correlation between stress and WTD.

Several statistical analyses were conducted to establish the level of significance for this comparison between the high and low work time deviation populations. A two-tailed, unequal variance small sample test, based on W. S. Gosset's "Student's t" distribution (see references), was conducted which resulted in a probability of only 0.0004 that the two samples were from the same distribution of population means. Therefore, the magnitude of the difference in the computed sample means indicates a true or statistically meaningful difference in the population means. In addition, a large sample test of hypothesis, testing the difference between population means, was also conducted (see appendix D). This test further indicates that a statistically significant difference in the population means can be inferred.

While the above analyses clearly indicate a meaningful and statistically significant numerical difference in the two work time deviation populations, they do not and can not suggest a cause and effect relationship or offer particular reasons for the lack of a strong positive correlation between WTD and stress levels. However, based on the overall information and comments contained in the interviews several reasons or explanations are offered below:

- Individuals accurately reported their stress levels and high work time deviations, (i.e., overtime work) actually does result in or represent a lower level of workforce stress. This circumstance was expressed by a number of the individuals interviewed with the explanation that, when necessary, a moderate level of overtime work was welcomed since it allowed the workforce to stay focused, energized with “motivational stress,” and on-task, i.e., overtime serves as a "relief valve" providing extra time to complete the work. This condition would seem to correspond to the maximum performance region or plateau area as indicated in figure 4.2. This condition is clearly preferred to the situation where the work schedule imposes long delays or periods of inactivity and/or numerous "starts and stops." In fact, the condition of on-call inaction, according to a number of the individuals interviewed, was a primary cause and generator of stress.

- Self-elected overtime, undoubtedly representing a very positive income supplement to the worker, provides individuals with increased flexibility in personal financial matters and thereby reduces overall life-stress.

- Individuals in the high work time deviation sample may have, either deliberately or unconsciously, assessed a lower level of stress to their job duties and work conditions so as not to jeopardize their future access to overtime and the increased income derived from overtime work.

- The work time deviation metrics as currently defined and used (see section 2.2) have not observed nor recorded that range or extent of overtime that could potentially result in stress and/or fatigue levels sufficient to jeopardize safe Space Shuttle operations.

4.3.3 Inferences between Task Loading, Stress, and Performance Effectiveness

The Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications (reference Swain and Guttmann) describes regions where too little stress results in inadequate "arousal" to achieve optimum performance. As stress increases so does arousal resulting in "facilitative stress." Their curve postulates increases in performance effectiveness up to a certain point of work loading. This is followed by a plateau or "optimum region" where little increase or decrease in effectiveness is associated with increases in workload. Finally, one observes a region in which effectiveness drops off significantly, so called "disruptive stress," with further increases in work or task loading. This is the “edge of the cliff region” where increases in work-induced stress and fatigue could pose a serious and credible threat to Space Shuttle operational safety.

All self-assessed stress levels from the present study fall in the low-to-moderate range (see tables 4.7 and 4.8). This result allows one to index (by approximation) to the low to moderate region on the stress axis of figure 4.2. This is the facilitative stress region which corresponds to the notional "optimum" task loading region.

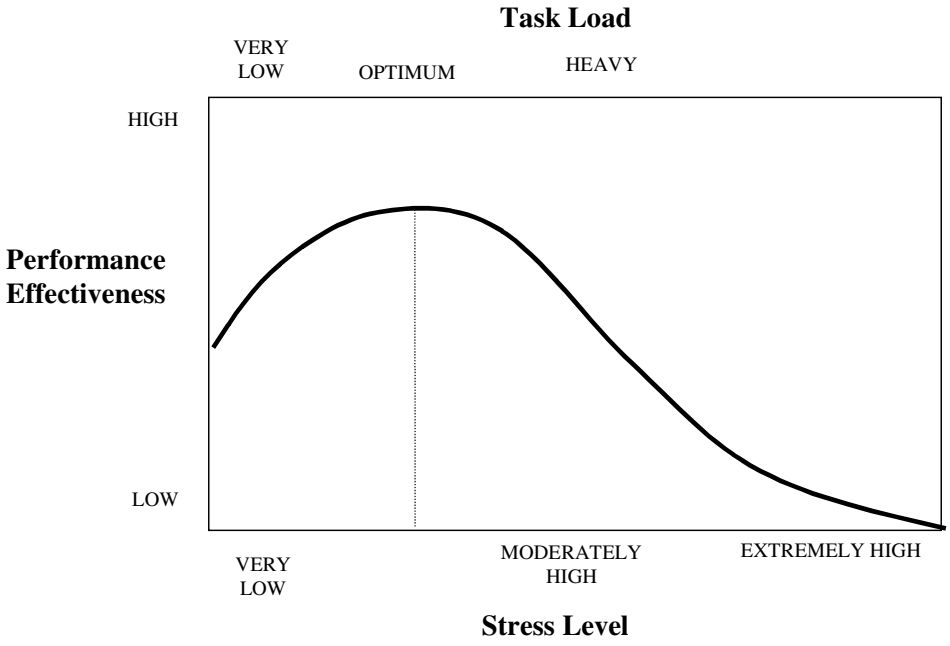


Figure 4.2 Hypothetical Relationship of Psychological Stress and Performance Effectiveness (based on Swain and Guttmann)

Thus, the self-assessed stress results when viewed in the context of the Swain and Guttmann model suggests that the current USAGO workforce is operating in an effective performance region.

4.4 Additional Information

During the planning phases leading up to the survey the IAT was briefed on the status of two ongoing SSP and USAGO initiatives related to workforce capability, metrics, and management.

4.4.1 Overview of Workforce Flexibility

The IAT was presented with several briefings describing the progress in development and validation of the NASA/USA Workforce Flexibility Model. This empirically-validated model provides an analytical projection of workforce capability versus manifest requirements. The model also incorporates the ability to identify skill mix and training/certification issues affecting workforce capability for various manifest scenarios.

4.4.2 Metrics (USA Surveillance)

The IAT was presented with a briefing on the USA initiative (currently underway) to restructure the Structured Surveillance program. The restructured program shifts focus from compliance to behavior, and stresses the relationship of behavior to errors and violations that can propagate through the system of processes resulting in unwanted events such as mishaps or in flight anomalies.

5.0 Findings and Recommendations

The objective of the independent assessment was to provide the NASA Administrator and the AA/OSMA with an independent assessment of the current USAGO workforce capability to safely process Space Shuttles under a four-orbiter-in-flow condition. The quantitative analysis of binary and Likert-scale data coupled with the qualitative evaluation of 958 individual narrative responses acquired in 36 hours of one-on-one interviews provides the basis for the team findings and recommendations.

5.1 Findings

5.1.1 USAGO Workforce Stress

- Under the sampling conditions (survey population, four-orbiter-in-flow, skill mix, staffing levels, experience level, etc.) and recognizing inherent sampling error and questionnaire limitations, the IAT finds that overall workplace induced stress does not appear to be a present safety concern. Based on the results of this assessment and the two previous assessments of USAGO workforce capability, the IAT reaffirms the previous findings that USAGO has established the capability to safely accomplish an evenly spaced flight rate of up to seven flights per year.
- Under the given sampling conditions the data indicates a slightly negative correlation between workplace-induced stress and work time deviations, i.e., overtime. This lack of an expected strong positive correlation, i.e., high levels of stress associated with high numbers of work time deviations, may have several explanations:
  - A moderate level of overtime work is expected and welcomed as it allows the workforce to remain focused, on-task, and energized with "motivational stress." This would appear to be consistent with the findings of Swain and Guttmann (see figure 4.2) which indicates that there exists some optimum or "minimal" level of task loading and attendant stress that maximizes performance effectiveness.
  - Self-elected overtime represents a positive income supplement and provides individuals with increased flexibility in personal financial matters thereby reducing overall life-stress. As a correlate, individuals with high WTD's may have deliberately or unconsciously assessed a lower level of workforce stress so as not to jeopardize future access to overtime work and the increased income derived therein.
  - Work time deviation metrics as currently defined and applied have not observed (can not observe?) that range of overtime that could potentially result in stress and/or fatigue levels, i.e., the far right portion of the Swain-Guttmann curve, sufficient to jeopardize safe Space Shuttle operations.
- Many workers note transient periods of high stress.
- First line supervisor subgroup reports higher stress levels on average than the technician or non-supervisor workforce.
- Scheduling changes drive stress.
- Late arriving parts (locally ordered as well as GFE from JSC) and paper (both

internally and externally generated) drive stress at KSC

- Delays, starts and stops drive stress.
- Skill-mix and training/certification imbalance imposes greater demands and stress on fully qualified (Level-1) workforce.
- Reported unsafe activities and/or conditions - a number of the individuals interviewed reported knowledge of unsafe activities or conditions in Space Shuttle ground operations (see 4.1.3 and appendix C).

5.1.2 Analysis and Interpretation of Binary Data (Questions 4 through 9)

Any set of data can be interpreted in many different ways. Indeed, this is the classic analysis of water in a glass being half empty? … or half full? In particular, the issue of what is an acceptable percentage responding yes or no to the binary questions of this survey begs the question – what is the yardstick or metric for acceptability or goodness? The following example illustrates this point.

Question #4 Time (One data set -Three perspectives)

The Optimistic Perspective

85% (the overwhelming majority) of people interviewed felt that they had adequate time to complete their assignments safely. The 15% not responding in positive manner can be dismissed as special exceptions, inherent sampling error, or anomalies.

The Conservative Perspective

15% of individuals interviewed felt that they did not have adequate time to complete their assignments safely. The conservative analyst, noting that lives are at stake, space travel is a one-strike-and-you-are-out enterprise, the Space Shuttle is a national asset, etc., can suggest that serious risks exist within processes in which 15% of the people performing critical activities do not have time to complete their tasks safely.

The Continual Improvement Perspective

15% of individuals interviewed felt that they did not have adequate time to complete their assignments safely. This represents a tremendous opportunity to assess how critical processes, work scheduling, and management emphasis can be balanced to assure that 100% of the employees performing critical work have adequate time to safely perform their tasks.

A similar tri-perspective analysis can be created for the questions concerning training, timely directions/parts, work instructions, checks and balances, and time-out policy.

5.1.3 Independent Assessment Team Perspective

The IAT (and the SSP) believe that Space Shuttle safety management goals must include:

- 100% acceptance and utilization of the time-out process,

- 100% of the workforce having time to safely perform tasks,
- 100% of the workforce receiving clear directions and instructions,
- 100% on-time delivery/availability of parts, etc.

The importance of "setting the bar high" or establishing stretch goals is a critical element in moving complex, high technology enterprises toward safety and success. The IAT acknowledges that while survey response data will never achieve 100% levels no goal other than 100% acceptance is defensible. Therefore, the IAT suggests the following continual safety improvement rule-set:

Safety Goals / Rule Set

#1 Safety goals should focus on achieving a workplace environment in which 100% of employees have the right tools, instructions, direction, and adequate time to do the job safely.

#2 Workplace satisfaction levels less than 100% represent the need for investigation, analysis, and potential improvement.

5.2 Recommendations

The following recommendations are offered to assist KSC SSP ground processing in moving toward these goals:

1. NASA KSC SSP management should commit to conducting independent workforce surveys on a periodic (e.g., semi-annual) basis. While the current survey represents only a snapshot in time it could serve as the starting point for periodic surveys that track workforce attitudes and perspectives regarding workplace satisfaction and safety. Future survey planning should consider sampling that includes all members of the workforce (including those individuals with zero WTD) as well as a wide range of questions addressing workplace factors that are recognized correlates to occupational safety and stress.

2. NASA KSC should continue to evaluate the KSC maximum work time deviation policy (as part of a broader NASA WTD policy assessment) to determine if changes are warranted. This reevaluation should:
   - consider the ability to measure/monitor stress and fatigue levels over the entire range of work load/overtime conditions (as shown in figure 4.2) including both high stress/high task loading as well as low stress/low task loading operational regimes.

- evaluate the need for WTD rules to limit initiation of hazardous or critical operations in the late hours of an extended shift (e.g., beginning a hazardous operation on hour eleven of an individual's shift) or conducting critical operations in the early morning hours.
- evaluate the implications of "double counting" as noted in section 2.2.

3. NASA KSC SSP and USAGO management should address and develop solutions for late paper and parts from both internal sources and external SSP elements.

4. USAGO should consider and evaluate the need for increased training opportunities for the 2nd shift work force and increased training opportunities in new technology areas.

5. USAGO should continue to assess and manage skill mix/training issues to more effectively and safely meet workload demands. The IAT recommends that the NASA/USA refine and implement the Workforce Flexibility Model as a viable means to address skill mix, numbers, and training/certification imbalances.

6. NASA KSC SSP and USA should continue current efforts that reinforce the critical importance of the timeout policy for all levels of the workforce (management, engineering, technician, administrative) and the goal of 100% acceptance.

7. USA Management should undertake efforts to better inform and educate the touch-labor work force regarding the purpose, value, and application of metrics, in general, and the WTD metrics, in particular.

8. NASA KSC SSP and USA management must redouble their efforts to improve workforce understanding and acceptance of Structured Surveillance as an important and necessary safety control process. The idea of structured surveillance as a means to maintain stable, capable, and controlled critical processes remains an excellent and essential concept for implementing checks and balances within the scope of a performance based contract.

9. NASA KSC SSP and USA should address each of the issues reported in section 4.1.3, validate their accuracy, and establish corrective action when validated.

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Appendix A - Executive Summary of Previous Space Shuttle Ground Operations Reviews and Independent Assessments

Overarching Goal: Continued Space Shuttle Safety

Specific Focus: Ground Processing – process stability, capability, and control

OSMA IA Team Assessment #1 (October 1998)

Objective: Determine if staff reductions (552 FTE) in USAGO will compromise ground processing fidelity and/or Space Shuttle safety.

Finding: Interlocking processes will prevent work from being performed in an improper way. Specifically, built-in process controls (i.e., work control, work review, and change control) will assure continued process stability and capability regardless of manifest demand.

OSMA IA Team Assessment #2 (April 1999)

Objective 1: Assess whether or not USA Strategic Initiatives will succeed in increasing process efficiency and thereby increase capability equivalent to the 552 staff reductions.

Finding 1: Proposed Strategic Initiatives would yield only 70% of projected full time equivalent (FTE) savings.

Objective 2: Estimate safe processing capability after implementation of the Strategic Initiatives.

Finding 2: USAGO processing capability (with 70% yield) would result in a 7 per year flow capability.

Objective 3: Assess whether or not planned Strategic Initiatives would potentially impact safety.

Finding 3: The review team concluded that implementation of proposed Strategic Initiatives would not compromise safety.

Appendix B - Sample Survey Questionnaire

Q1. What can go wrong with your work process that could result in unsafe Shuttle operations?

Q2. What metrics (if any) are being used to monitor your work process?

Q3. What metrics should be/could be used to more effectively monitor your process?

Q4. Do you feel you have sufficient time to complete your assignment(s) safely?

Q5. Do you feel you have sufficient training/training opportunities/certification to safely accomplish your job duties?

Q6. Do you feel you receive timely direction and proper paperwork (paper/parts/etc.) to accomplish your job duties safely?

Q7. Do you feel you receive clear and correct work instructions to accomplish your job duties safely?

Q8. Does your work process(es) have sufficient checks and balances (e.g., inspections) to preclude unsafe operations? If so, what are they? If not, what would you suggest (e.g., an extra pair of eyes, an additional inspection point, etc.).

Q9. Do you feel that it's o.k. to call a "timeout" when you see safety violations or unsafe behaviors without fear of adverse action? (Is the policy clearly defined? Is it clear to you when to use it?)

Q10. Are there things or conditions in other areas that you know about that are unsafe or could lead to an unsafe condition?

Q11. Indicate your current average level of workplace-induced stress using a scale of one to five where one indicates no stress, two indicates low stress, three indicates a neutral response, four indicates moderate stress, and five indicates high stress.

Appendix C: Individual Survey Question Responses and Data

Question 1: What can go wrong with your work process that could result in unsafe Shuttle operations?

Org Code	Ref#	Supv	Short Resp	Q1 Narrative
51000				
	86	y		Top three worries are: 1) follow procedures, 2) follow procedures, 3) follow procedures.
	84	y		Not following directions can lead to safety or quality problems.
	53	y		Self-imposed pressure to complete job. Combination of inexperienced engineers and technicians.
	31	y		Possible unsafe mode (but highly unlikely) skipping a procedural step or system is not capable of detecting a problem. However both of these would likely be detected later.
	47	n		Don't do a proper safety assessment of vehicle toxics.
	26	n		Processes have been improved/revised to the place where if followed the operation will be safe.
	36	n		Process has such redundancy as to preclude unsafe operations - deliberate sabotage is the only possibility.
	28	n		No Response
	70	n		Different reading or interpretation of the paper. Provided example of where USA/Q, NASA/Q and available engineering support - all were wrong in interpretation, waited for author/engineer to clarify.
	59	n		Dropping flight hardware.
	92	n		Landing and possibility of leaks/going into escape operation Working at heights.
	54	n		Not following paper work or procedures. Incorrect paper work.
	75	n		Certifications for landing & Dryden support. Likes to work overtime (2nd shift worker) would like 60-70 hours. Random observations: - need more faith, trust, and skill level/fifteen years average. - crew small/close knit team. - personal problems minimized. - process may be too clean.
	76	n		Personal danger due to inadvertent RF energy exposure.
	55	n		Servicing of hazardous commodities. Suspended load operations.

Org Code	Ref#	Supv	Short Resp	Q1 Narrative
	49	n		Personnel safety Issue - eliminated "buddy system" (not in writing or WAD). ECS readings on weekends - checking all four orbiters alone in high noise area.
	27	n		FAA comes in and realigns every three years. MSBLS alignment conducted every two years. Responsible for alignment and power.
	82	n		"Anything that moves - during functional checkouts" our prime job. Jobs are run from the firing room - this builds in risk because of remote location. Nothing is routine with major functional tests of electrical and mechanical systems. "Look for Murphy."
	41	n		Nothing, they do everything right.
	87	n		When a test conductor shuts down at 3:30 pm on Friday afternoon in the middle of a critical operation the potential exists for error when restarting.
	88	n		Lots of hazardous operations - almost anything.
	22	n		Pretty remote likelihood that safety is compromised by stowage activity. Not following the paper is a potential problem.
	34	n		Work is performed to Problem Reports, OMI's, and job cards.
	91	n		No response.
53000				
	46	y		Fallacies in safety controls for monitoring atmospheric toxic and hazardous commodities. Setting up and maintaining "clears" for non-essential personnel.
	33	y		Procedures in place for many years.
	65	y		With hands-on people, lots of things - mechanical/electrical equipment, lots of people, many opportunities for error.
	50	y		Being schedule driven. Miss a sling move. Fueling operations at pad.
	21	n		Wrong/bad parts. Noted concerns with incorrectly assembled parts as a potential failure scenario.

Org Code	Ref#	Supv	Short Resp	Q1 Narrative
	44	n		Nothing comes to mind.
	83	n		Not adhering to safety procedures, e.g., not using PPE. Fueling the RCS could lead to problems.
	48	n		Lack of communications. Component failures.
	64	n		Missed wiring faults in testing.
	85	n		Leak in a cryo valve is a concern. Has a small group of new (young guys) - good team they have a close relationship with engineering.
	67	n	Nothing	
	52	n		Bad communications on any/all levels.
	81	n		"Management push is a problem." "To do new things without proper understanding / management assumes you have done it."
	40	n		Technicians not happy about doing safety's job.
	78	n		Hypergolics monitoring now a tech responsibility (implies an issue). Techs must now carry breathing air meters.
	90	n		Communications between firing room test conductors and pad personnel before you hit a button that causes something to move.
	37	n		Most work is performed in a hazardous operation that requires escape and harnesses.
	58	n		If you didn't do the right job or didn't check it. Feels USA and NASA QA team is doing a good job. Lots of corporate memory/great crew.
	71	n	Lots	Ordinance operation, FOD, MLP, and Pad have flakes of metal everywhere - potential is large to cause extensive damage to aft end of orbiter.
	69	n		No response.
	61	n	Nothing	Good with unplanned work.
	62	n	Nothing	

Org Code	Ref#	Supv	Short Resp	Q1 Narrative
	68	n		Explosives and fuel. Errors in judgements. Human factors, paperwork, and parts needs.
	74	n		People represent error potential.
56000				
	80	y		No response.
	30	y		Aging equipment and lacking budget support to many of the water suppression GSE, i.e., losing fire protection could place orbiter/crew in jeopardy.
	73	y	Nothing	
	24	y		Major concern that the crawler could fail (be disabled) between VAB and Pad and vulnerable to adverse weather impact.
	32	n		Following procedures for years with streamlining over the years.
	23	n		Failure to follow the procedures is a potential failure scenario.
	29	n		The process is generally OK but schedule pressure at times (i.e., parallel processing) might cause a mishap or a hazardous situation.
	35	n		Less people for the process. 35 year old equipment (i.e., crane) handling multi-million dollar hardware.
	25	n		Follows his processes which are easy to follow.
	38	n		Safety cannot be impacted, only schedule.
	39	n		Lack of communication between ground observers and the operators could result in a problem, however the likelihood of occurrence is low.
	42	n		Improper or incomplete pump maintenance.
	43	n		Moving booster segments.

Org Code	Ref#	Supv	Short Resp	Q1 Narrative
	45	n		Not following paper work. Lack of attention to detail. Sometime the paper work is not tracking the system - very rare.
	51	n		Conducting operations too fast - "Don't get in a hurry." Short of manpower on 2nd shift.
	57	n	Nothing	
	60	n		Dropping flight hardware.
	63	n		Areas may not be cordoned off, i.e., high platform work at the pad. Rigging (USA Safety responsible for this).
	66	n	Nothing	
	72	n		Must follow instructions. Must work to print.
	77	n		Sound suppression problems - water quenching during launch OPF 1,2,3 potable fire water.
	79	n		No response.
	89	n		Everything is critical when handling flight hardware. Must know what you are doing and be always careful. Communications are supercritical in our work - must have backup (i.e., radio communication system).
	56	n		No response.

Question 2: What metrics (if any) are being used to monitor your work process?

Question 3: What metrics should be/could be used to more effectively monitor your process?

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
51000				
	y	86	First time quality is best metric (Notes that their team has a first time quality rate in upper 80 percentile).	"We are metriced to the max" considering OSHA and safety. VSP board and OSHA recordables are the best. Vision support plan rolls up all of the metrics.
	y	84	Process surveillance (USA). Safety surveillance (USA and NASA). We use surveillance metrics to see if we have any write-ups. Flash reports are also used to flow-down safety information. Being proactive (walking around first line management) is the best metric.	No response.
	y	53	Structured surveillance - content with "whats being done" not "how its being done." Schedule stability for jobs scheduled - what is workable, what is not, and why not.	Need "time to completion" metric. Number of days without serious accident/injury.
	y	31	Process surveillance. Four to six times per month his job is randomly selected for checks. Feedback is provided to employees, errors are described and shared with other engineering groups. NASA engineering reviews. WADS(~20/month) for completeness and missed requirements - feedback is provided.	Getting a good perspective with the Q2 metrics.
	n	47	ISO 9000 NCR's.	No response.
	n	26	Aware of process or structured surveillance. The metrics verify conformance to process and paper. Feedback is provided concerning surveillance results. Workmanship problem reports are also tracked. Palm pilot personnel are not "user friendly" - not part of the team - us verses them mentality.	Nothing additional.
	n	36	Process is well defined - no obvious metrics. Safety program for assessing processes just instituted.	Safety study after safety study - most of the time it's a waste of time. Management asking you to do their job - imposing on an already thin workforce.

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
	n	28	"PETA sheets" are used to verify compliance with requirements. TAM sheets are also used. Process surveillance is also conducted.	None.
	n	70	Palm nazis write up the wrong stuff. Palm nazis not respected - a stupid annoyance. Gave example of writing someone up for not wearing safety glasses and a face shield to perform simple task with solvent.	Safety is embedded in people - not surveillance. Surveillance does not add to safety.
	n	59	Good QA - good response from NASA, they get involved and sometimes help. Believes super would get in the way - no help. Needs to get in and out fast.	None.
	n	92	VSP board is useful to track your certification status.	None.
	n	54	Don't see any.	
	n	75	Records of past fail rates. IPD sheets. Step-by-step paperwork (WADs).	Nothing.
	n	76	CAM process unclear. Supervisors look over work instructions, review the work for tech errors, log data to monitor overtime (looking for fatigue).	None.
	n	55	Structured Surveillance.	Use data codes ("hold" codes/"delay" codes) during the tie-in process, i.e., how often used? If used?, etc.
	n	49	VPP status board.	
	n	27	All work is documented and approved by engineering and/or supervisor. ISO audits are also conducted.	"Safety is the rule."
	n	82	Standard safety metrics are key - any off nominal events. Flash reports and PERs are very important. They also use the tie-in system to bring issues to management attention.	No response.
	n	41	Metrics in place but individual is not involved with them.	None that I can think of.
	n	87	Currently does not use metrics.	Track late hardware arrivals from Houston. Track paper changes from Houston.
	n	88	Hundreds of metrics are being used i,e., Devs, PRs. We are over-metriced right now - we are overwhelmed with processes for acquiring and tracking data. It is metric fever - we are overwhelmed!	Quality of paper metrics. Real-time deviation problems with the paper - people are reluctant to write deviations. Work stoppages related to the paper.

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
	n	22	"Not much." Auditors verify job is per paper. Another group verifies parts numbers.	Potential metrics: - metrics on late delivery - actual stowage time
	n	34	Not aware of any metrics. Human factors guys (sic) come around and try to help. Surveillance quality control (Palm Pilot).	Shop floor data collection should be utilized more. History/tracking/resolution of problems should be documented and lessons learned from it.
	n	91	No.	I got my book, I got my QC - what else do I need? Structured surveillance is the biggest waste of time they ever came up with.
53000				
	y	46	First time quality and safety reports, i.e., structured surveillance.	No response.
	y	33	Weekly self-structured surveillance. First line supervisor performs a weekly "walk down" of egress routes, lighting, fire safety, and the results are placed on the web-based SFOC integrated safety "walk down" check.	Developed his own metrics tailored from the web-based SFOC integrated safety standard.
	y	65	Quality, safety, task readiness measures, and some cost measures.	No response.
	y	50	Specific safety metrics; - clears, - "what stage we're at," - schedule.	No response.
	n	21	NASA engineering reviews WADS. Palm pilot surveillance. Technical Accuracy Method (TAM) - self monitoring of paper.	Believes that sufficient metrics are currently in-place.
	n	44	Structured surveillance. USA and NASA QA. Safety personnel.	No response.
	n	83	Don't know.	We know they are trying to make the instructions better - without so many cross-references.
	n	48	Not aware of any.	Develop and monitor process to minimize pad debris at lift-off.
	n	64	Level 2 testing. Paperwork- completed tasks reported to work.	What they are currently doing is adequate. Testing may not be adequate - working to modify testing/following industry standards but this may not be adequate/test more stringently than normal but failures can still happen.

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
	n	85	Sees no value in structured surveillance - "Palm nazis" are almost like harassment. Paper gets better every day. Constantly improving methods.	Overtime metrics - keeping it low says things are OK.
	n	67	Checklists. Job Task Sheets. Report Back.	No response.
	n	52	Not aware of any structured metrics. "If launched successfully, we did our job."	No one thing would make it better. Side tracked with metrics, not value added. Taking time away from work, i.e., CIP (Continuous Improvement Program).
	n	81	"No value in metrics." "We stop working when we see the palm nazi's coming. " "Structured surveillance needs to go away." "These people create a lot of animosity."	No additional comments.
	n	40	Call sheets for job assignments.	No, what we have in place is fine.
	n	78	Paper work cut and dried - turn in paperwork/steps are stamped.	New computer system processes (i.e., MAXIMO) but computer outages a problem - not reliable - prefers paper.
	n	90	Weekly swing arm examination of Paper. QC infield check. Structured surveillance considered to be a Gestapo operation - seen as a trivial activity.	No response.
	n	37	Start and stop times are being maintained by someone. Metrics on alignments. TAIR station maintains all records of work and incidences.	No response.
	n	58	Daily schedules. Supervisor dictates work in timely fashion. Briefings at start of shift - coordinate with Leads as job is completed.	Greater tie-in across shifts both verbally and with paper.
	n	71	They have improved and streamlined the WADS -"more and more and more clear." PPICI is a good process.	The metrics are embedded in the work instructions.
	n	69	USA quality, NASA quality, tie-in meetings between shifts , structured surveillance ("I don't know what they do - they don't tell us what they do").	No response.
	n	61	Report back to payload ops when job complete. Leads report back to scheduling.	When no vehicle on pad, they should do routine maintenance. Use written forms for assignments. Need to track what new people are doing - not rely on memory.

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
	n	62	Checklists. POC's & operations. Supervision.	No response.
	n	68	Monitor selves - much QA and Safety. Critical items - NASA and USA Safety only.	No response.
	n	74	QA inspection, document inspection. Engineering available for procedural questions or h/w questions. Checklists employed by task leaders.	Better interface with engineering is required for understanding.
56000				
	y	80	Does not like metrics. PM planned maintenance metric. Equipment down time metrics. Down time is a good metric - (proportional to safety) indicates how well our equipment operates.	Measure backlog work orders. Easier to do maintenance with planned/ continuous launch schedule. Plan,plan,plan, and plan - however, planning is often disjointed.
	y	30	Takes own metrics of her work crew, i.e., sick time/over time/time off. People who have personal problems are provided with appropriate time off. USA metrics are: - preventive maintenance, - stop light (green/yellow/red), - accidents, - overtime deviations, - OSHA.	See Q2.
	y	73	Priority lists. Field surveillance. Readiness review lists. PM monthly report. Talking to techs and engineers.	Scheduler Program - resources versus schedule (under development). MAXIMO.
	y	24	Preventive maintenance. Lost time injury and on-the-job first aid injuries.	Concerned that employees sit and wait unnecessarily. Measure the "sit around and wait time." Points out that managers use this approach to "capture" critical resource skill groups.
	n	32	Structured surveillance is performed - feedback is never provided. Safety comes around periodically, however, identified safety issues should be resolved more quickly instead of the bureaucratic stuff they do.	No response.
	n	23	Not aware of any metrics being taken.	None.
	n	29	Not aware of any.	I would like someone to measure the period between scheduled and actual start time.
	n	35	Lost time accidents.	Monitor nonqualified/noncertified people.

Org Code	Supv	Ref#	Q2 Narrative	Q3 Narrative
	n	25	Auditors show up to verify that OMI's are being conducted properly. From time to time people show up to ask how you are doing.	None.
	n	38	Preventive maintenance metrics are maintained by the supervisor. Monthly charting of preventive maintenance needs to be worked.	Sufficient metrics in place.
	n	39	Not aware of any.	No response.
	n	42	Monitoring weekly maintenance.	No response.
	n	43	Going by paperwork. (Not familiar with specific metrics.)	No response.
	n	45	Measuring work process as jobs are completed - "buy off" each step as performed, i.e., MAXIMO. Use of standing work orders.	Use lap-tops to monitor problems/problem corrections, i.e., lessons learned.
	n	51	Safety meeting every day but no specific metrics.	None, no more than what we already do. Don't know how we would measure.
	n	57	QA. Manager and crew chief inspection. Step-by-step details written down. Good paper.	Nothing.
	n	60	Safety person is there most of the time; - but not enough of them from USA, - NASA is there sometimes.	More hands-on supervision; - lapses between shifts, - left on own a lot. He is expected to have corporate memory and expertise - feels a lot of stress.
	n	63	PPE safety matrix for each activity. Safety meetings every Tuesday morning. Management works to resolve stated safety issues. Good relationship with safety.	No response.
	n	66	Checklists - report to task leader when complete.	No response.
	n	72	Metrics not a big part of the job. Metrics is checking ones own work.	No response.
	n	77	Use written procedures (metrics embedded). Check lists. Problems sent to engineering.	None.
	n	79	None.	None.
	n	89	No.	None.
	n	56	Maintenance inspections. Task list checkoff - issues brought forward.	No response.

Question 4: Do you feel you have sufficient time to complete your assignment(s) safely?

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	61	**85**	11	**15**
Supervisors	12	all	8	**67**	4	**33**
Non-supervisors	60	all	53	**88**	7	**12**
Horizontal Processing (All)	24	51000	16	**66**	8	**34**
Supervisors	4		2	**50**	2	**50**
Non-supervisors	20		14	**70**	6	**30**
Vertical Processing (All)	24	53000	23	**96**	1	**4**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	22	**91**	2	**9**
Supervisors	4		2	**50**	2	**50**
Non-supervisors	20		20	**100**	0	**0**

Org Code	Ref#	Supv	Short Resp	Q4 Narrative
51000				
	86	y	yes	We take the time - whatever time is required - just do the best you can.
	84	y	yes	"We always have an allotted time but we never rush - if they don't make it, they don't make it - safety is more important than time."
	53	y	n	Most of the time, there are times when ops desk or scheduling people are asking for completion.
	31	y	n	Test are serial in nature and completing on time is critical to the next process. At times this results in pressure to complete. Part of the problem is related to worker experience level. Forty percent of the people have greater than ten years, forty percent have less than 2 years, other 20% in between.
	47	n	yes	
	26	n	yes	
	36	n	n	Sometimes yes. Sometimes no - there are times when they are pressured by circumstances.
	28	n	yes	
	70	n	yes	You never have to finish a job - just find a good stopping point.
	59	n	no	Problems getting GFE from Houston in time to get it to the pad and stow for launch. Feels he is always playing catch up. Pressed to get work done plus extra work. Stuff always arrives late.
	92	n	yes	Yes - sort of - we always have time. Feast or famine. People focus on 7-10 day schedule constraints. Landing at DFRC is a lot of work. Recent example (Feb 01, STS-102) included 20 hour work days followed by 14 hour work days/36 degree midnight operations in driving rain for no good reason (possible photo-op of two 747/orbiter configurations). Someone could have been killed that night. Definitely increased chances of making a mistake. Vehicle sat for three days, rush-rush-rush/ wait-wait -wait. We need to follow our own rules.
	54	n	n	Sometimes yes, if on the net. Sometimes no, for local work handling hazardous waste.
	75	n	yes	
	76	n	yes	
	55	n	yes	
	49	n	yes	Absolutely.

Org Code	Ref#	Supv	Short Resp	Q4 Narrative
	27	n	yes	Yes, for the most part.
	82	n	no	"I like to take the time I need. Downsizing, lack of personnel and schedule pressure results in lots of overtime. I can find my performance degrading by hour 10, 11, or 12. We don't have enough level-1 certified people.
	41	n	n	Loss of experienced people and, hence, increased training needs for new people consumes time available to complete process. It is a workload related issue - minimal problem for flight rate of 4/yr. - bigger problem for flight rate of 7 or more.
	87	n	no	Yes - if we have equipment. It has been getting worse over the past three missions. No - with last minute changes there is a lot of stress - extremely hectic.
	88	n	yes	Safely-yes. Do I wish I had more time - absolutely.
	22	n	yes	Yes, most of the time, however a trend in late hardware delivery is developing. This is not a safety impact but represents a schedule impact.
	34	n	yes	However, with increasing landing rate, pressure is increasing. Additional certified electrical technicians would help.
	91	n	yes	More than enough. "There is an illusion of schedule pressure." "It exists only if you allow it to exist. If it takes longer, it takes longer."
53000				
	46	y	yes	
	33	y	yes	With a flight rate of 6/yr and with two month centers it should be OK.
	65	y	yes	
	50	y	yes	
	21	n	yes	Typically enough time, however West Coast landings "can create a little pressure."
	44	n	yes	
	83	n	yes	Yes - but we wear too many hats. Tech/Quality/Safety/Engineering = too many hats.
	48	n	yes	
	64	n	yes	
	85	n	yes	"Without a doubt - there is no pressure to get it done by a schedule - if we need more time we take more time."
	67	n	yes	
	52	n	yes	Generally, yes.
	81	n	yes	
	40	n	yes	
	78	n	yes	

Org Code	Ref#	Supv	Short Resp	Q4 Narrative
	90	n	yes	If we don't, we take the necessary time.
	37	n	yes	
	58	n	yes	
	71	n	yes	We could have better scheduling. Scheduling and planning could improve communications, especially on the pad.
	69	n	yes	"Time is never an issue - if I feel I don't (have enough) I let them know - there is always the next day or the next shift."
	61	n	yes	OT is normally granted/continues work until it is done. Mgmt. is good about providing the OT to get job done.
	62	n	yes	
	68	n	n	Most of the time - schedule changes causes backups, turns into OT (week before launch).
	74	n	yes	
56000				
	80	y	no	As a department, no. Don't have the depth to check engineering work, but checks and balances exist. "We are hurting for manpower." "Measuring backlog work would show the lack of manpower."
	30	y	n	20% of the time there is insufficient time. Shuttle tech managers often apply pressure before ready to accomplish/or meet schedule.
	73	y	yes	
	24	y	yes	"Yes I do - no problem."
	32	n	yes	
	23	n	yes	"Everything has to be done at once. However priorities are established. If it is not completed on time it is passed on to the next shift. Safety is not a concern but schedule impacts are possible."
	29	n	yes	Yes generally, occasionally while in the OPF, late starts force a hurry up attitude.
	35	n	yes	
	25	n	yes	Generally sufficient time is allowed.
	38	n	yes	Most of the time, however launch operations can and have impacted preventive maintenance schedule. Not enough people.
	39	n	yes	
	42	n	yes	
	43	n	yes	
	45	n	yes	Most certainly.
	51	n	yes	Yes, at present.
	57	n	yes	

Org Code	Ref#	Supv	Short Resp	Q4 Narrative
	60	n	yes	"Most of the time."
	63	n	yes	Scheduler gives work orders in the morning - no one pushes, no one questions time. High crew - a lot of improvising for unique access - problems are rare.
	66	n	yes	
	72	n	yes	It is a given you take the time to get the job right. Never in four years with USA have I been rushed to do the job without verifying that it is right. Safety and quality are always #1.
	77	n	yes	
	79	n	yes	
	89	n	yes	We work around the clock - it is always a slow process and we take our time. If we have to wait - we wait.
	56	n	yes	

Question 5: Do you feel you have sufficient training/training opportunities/certification to safely accomplish your job duties?

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	64	**89**	8	**11**
Supervisors	12	all	10	**83**	2	**17**
Non-supervisors	60	all	54	**90**	6	**10**
Horizontal Processing (All)	24	51000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**
Vertical Processing (All)	24	53000	22	**91**	2	**9**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		18	**90**	2	**10**
Ground Support (All)	24	56000	20	**83**	1	**17**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		17	**85**	3	**15**

Org Code	Ref#	Supv	Short Resp	Q5 Narrative
51000				
	86	y	yes	A good training process. QUACKS is a good system.
	84	y	yes	Yes - adequate/always available.
	53	y	no	Most of the time.
	31	y	yes	Official training is sufficient. New employees are mentored by experienced personnel. Some annual training (repetitive) is non-productive.
	47	n	yes	
	26	n	yes	Definitely.
	36	n	no	For experienced people, yes - for new people, no - not enough money for training.
	28	n	yes	
	70	n	yes	
	59	n	yes	Need more training ops during second shift.
	92	n	yes	
	54	n	yes	Yes, needs to be more re: handling hazardous waste and the responsibility of handling hazardous waste.
	75	n	yes	Yes, an overabundance but mainly on first shift. Takes a day of fatigue to adjust after 1st shift training for second shift workers.
	76	n	yes	
	55	n	yes	
	49	n	yes	
	27	n	yes	Yes, for the areas I am responsible for, although I would like some training in some other areas.
	82	n	yes	Absolutely.
	41	n	yes	
	87	n	yes	
	88	n	yes	
	22	n	yes	
	34	n	yes	Continual annual training in systems, i.e., PRACA is unnecessary.
	91	n	yes	Yes, but a lot of training is so redundant it is a waste of time. Recertification training for three days is a waste for experienced people. Training empire and politics drives the unnecessary requirement.

Org Code	Ref#	Supv	Short Resp	Q5 Narrative
53000				
	46	y	yes	
	33	y	yes	
	65	y	yes	
	50	y	yes	
	21	n	yes	
	44	n	yes	
	83	n	yes	Yes, absolutely. Quality Certification Sign-off System (QUACKS) recertification process is great. Classroom certification was a waste of money. QUACKS has OJT followed by simulator training.
	48	n	yes	
	64	n	yes	
	85	n	yes	
	67	n	yes	
	52	n	yes	Yes, training is adequate.
	81	n	no	No, I do my own training, our training coordinator is clueless. No one schedules my training and my certifications expire. QUACKS is a good deal though, lots of people manage these by themselves.
	40	n	yes	
	78	n	yes	
	90	n	no	Yes - plenty of training. Yes - plenty of certification. No - with respect to OSHA PPE requirements for developing WADs (needs some OSHA training) - need better USA safety support to people writing WADs.
	37	n	yes	
	58	n	yes	(Second shift worker) Most of training is available only on the first shift - this creates a problem.
	71	n	yes	More than sufficient - excellent training. QUACKS training provides recertification by OJT + computer course - a really good approach.
	69	n	yes	Generally positive. "Some training classes need follow-up with hands-on OJT."
	61	n	yes	Not facing any training obstacles - most of work requires OJT and he gets OJT.
	62	n	yes	Day (1st shift) training OK.
	68	n	yes	
	74	n	yes	

Org Code	Ref#	Supv	Short Resp	Q5 Narrative
56000				
	80	y	no	Not enough technician/technical training. There is career development training - that is ok. Training budget is cut, cut, cut. Optimistic about new certification training program in-work (i.e., home-grown training).
	30	y	yes	
	73	y	yes	
	24	y	yes	Yes.
	32	n	yes	However, additional training on newer equipment (smaller lifting equipment) would be beneficial.
	23	n	yes	He receives on the job training, and he trains new employees.
	29	n	no	I want more training on the new technology that I operate. The engineers get the training. It would be useful to give that training to the operator as well.
	35	n	no	Not sufficient training for touch-labor workforce relative to training for engineering workforce.
	25	n	yes	
	38	n	yes	
	39	n	yes	Yes, to perform present duties. However, additional training opportunities are not available due to budgets.
	42	n	yes	Could use additional training, i.e., at CAT, Fairbanks.
	43	n	no	Need more experience (SRM's and OTS) and training opportunities.
	45	n	yes	Maybe more than needed - overdoing training, particularly for older/experienced workforce. Tailor training sessions to level of work force experience.
	51	n	yes	Yes, very well trained.
	57	n	yes	
	60	n	yes	Now there is a good program - much improved. Big learning curve in my job - can't just read a manual. Would prefer classes for new students rather than having to mentor students. (On second shift by choice - third shift is really hard to do.)
	63	n	yes	Certification is required for everything. - 1st shift training is on first shift. - Some certification on 2nd shift.
	66	n	yes	
	72	n	yes	OJT training is available and is good.
	77	n	yes	Too much (mandatory) training.
	79	n	yes	Training is really good.
	89	n	yes	
	56	n	yes	

Question 6: Do you feel you receive timely direction and proper inputs (paper/parts/etc.) to accomplish your job duties safely?

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	57	**80**	15	**20**
Supervisors	12	all	9	**75**	3	**25**
Non-supervisors	60	all	48	**80**	12	**20**
Horizontal Processing (All)	24	51000	20	**83**	4	**17**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		16	**80**	4	**20**
Vertical Processing (All)	24	53000	16	**67**	8	**33**
Supervisors	4		1	**25**	3	**75**
Non-supervisors	20		15	**75**	5	**25**
Ground Support (All)	24	56000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**

Org Code	Ref#	Supv	Short Resp	Q6 Narrative
51000				
	86	y	yes	
	84	y	yes	
	53	y	yes	
	31	y	yes	
	47	n	yes	
	26	n	yes	Yes, paper and parts are timely.
	36	n	yes	On-site at KSC, yes. Overseas operations, no - communications sometimes a problem.
	28	n	yes	Yes, paper is self-generated. Parts are generally available, but some logistics problems exist, especially getting electronic parts.
	70	n	yes	Most of the time. Sometimes can't find parts kits. They should leave them in Logistics - don't stage it and leave it on the floor.
	59	n	no	Changes to work without proper paperwork causes compression of work assignments.
	92	n	yes	
	54	n	yes	
	75	n	yes	
	76	n	yes	
	55	n	no	There are some problems - lack of experience in engineering, i.e., writing paper but do not understand system. "Experience" has retired, now hiring new/freshout people.
	49	n	yes	
	27	n	yes	Paper is self-created. Parts are self-ordered and arrive on time.
	82	n	yes	"Yes, in general but management direction is uneven, for example sick time policy. If you take more than 4 days sick leave per year it is a minus ten percent on your performance evaluation. Green time, or contributed time is an offset." "The policy is nebulous - not in writing - but exists - it creates bad morale and an unprofessional environment."
	41	n	yes	
	87	n	no	Late paperwork and late hardware from JSC is a major problem.
	88	n	yes	I provide the paper.
	22	n	yes	Paper - yes, however parts are late about 5% of the time (Russian hardware and late engineering changes).

Org Code	Ref#	Supv	Short Resp	Q6 Narrative
	34	n	no	Paper is available about 50% of time it is scheduled to be available. Parts are available about 25% of the time it is scheduled to be available.
	91	n	yes	Feels it is his responsibility to seek it out. Not very positive.
53000				
	46	y	no	
	33	y	no	Paper is OK, getting the parts is a problem. (N204 corrosive and degrades parts rapidly.)
	65	y	yes	Yes, most of the time.
	50	y	no	We do, but could be improved. Time lines over the years (past four years) have significantly improved.
	21	n	yes	"We write the paper." Parts typically arrive on time.
	44	n	yes	Sometimes there is a problem with paper work. There has been steady improvement - CIP to TQM to People Soft.
	83	n	yes	Yes - we tailgate every morning - it really helps. Lead techs and supervisors hash out what we need to do.
	48	n	no	Not always - true for both people and paper.
	64	n	yes	Mostly unexpected failures - no pressure to get them done but we work diligently to try to get things accomplished as expediently as possible.
	85	n	yes	"There exists great engineering and technician teamwork."
	67	n	yes	
	52	n	no	No, paper work is not on time.
	81	n	no	The paper is never right, hardware kits are never right, floor support people screw-up all the time. "95% OK and 5% wrong kills you - you stop for hours."
	40	n	yes	
	78	n	yes	
	90	n	yes	He writes the paper.
	37	n	yes	Paper is good. Parts availability is a concern. Vendors no longer exist and replacement parts don't always fit.
	58	n	yes	
	71	n	yes	Without a doubt.
	69	n	yes	"I do and if I don't for any reason, I wait."
	61	n	no	PAD not well integrated with OPF - example: sometimes the case that OPF forgets to do this or that so assignment goes to pad and paper shows up but the parts are almost always missing - overloads normal Pad work schedule.
	62	n	yes	

Org Code	Ref#	Supv	Short Resp	Q6 Narrative
	68	n	no	Day before or day of work finding out what's doing. Paperwork and parts not ready - more overtime.
	74	n	yes	"Most of the time"
56000				
	80	y	yes	We generate the paper- we are the engineering group. MAXIMO is a help. Parts issues are tied to govt. acquisition process. Why not go to COTS for non-flight hardware? NASA incurs a great cost to maintain warehouse of stuff you can get at Home Depot.
	30	y	yes	Paper is self-generated. Parts delivery is a serious problem in accomplishing the job on time.
	73	y	yes	
	24	y	yes	Paper is on time. Parts are generally on time.
	32	n	no	Paper is OK, directions OK, parts availability is a concern.
	23	n	no	50% of the time paper is sent back to engineering for correction, revision, or clarification. Blames the MAXIMO system. "Sometimes the machine causes a problem with the WAD." Parts are generally (90%) delivered on-time.
	29	n	no	Clear direction is provided (what needs to be done). Paper is confusing at times - too many steps (MAXIMO system) - too many micro-steps. Parts come in late, sometimes they are wrong.
	35	n	yes	
	25	n	yes	Paper is clear and correct. Parts are generally available. On occasion parts are not available.
	38	n	yes	Paper is complete and parts are generally made available when needed.
	39	n	yes	Paper is self generating. Timely direction is provided. Logistics has been and continues to be a problem over an eleven year period and in all groups worked in.
	42	n	yes	
	43	n	yes	
	45	n	yes	Very much so.
	51	n	yes	
	57	n	yes	
	60	n	yes	As good as it can be.
	63	n	yes	
	66	n	yes	
	72	n	yes	Always.

Org Code	Ref#	Supv	Short Resp	Q6 Narrative
	77	n	yes	
	79	n	yes	
	89	n	yes	If we have to wait - we wait.
	56	n	yes	

Question 7: Do you feel you receive clear and correct work instructions to accomplish your job duties safely?

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	63	**88**	9	**12**
Supervisors	12	all	11	**91**	1	**9**
Non-supervisors	60	all	52	**87**	8	**13**
Horizontal Processing (All)	24	51000	20	**83**	4	**17**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		16	**80**	4	**20**
Vertical Processing (All)	24	53000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**

Org Code	Ref#	Supv	Short Resp	Q7 Narrative
51000				
	86	y	yes	
	84	y	yes	If we are not happy with the paper we call the engineers and seek clarification.
	53	y	yes	Most of the time.
	31	y	yes	Self-generated from OMRSD's. Some improvement lately - mixing text with figures.
	47	n	yes	Updated OMI's.
	26	n	yes	For the most part they are good. Systems engineers are readily available when questions arise.
	36	n	yes	
	28	n	yes	
	70	n	yes	Greater than 90% of the time.
	59	n	no	See comments about sufficient time.
	92	n	yes	Yes, for the most part. Some paper needs to be clarified.
	54	n	no	Sometimes yes, sometimes no - about 50/50.
	75	n	yes	
	76	n	yes	
	55	n	no	See response to previous (Q6) question.
	49	n	yes	
	27	n	yes	
	82	n	yes	Yes - written procedures.
	41	n	yes	
	87	n	yes	Yes - for the most part. We have an engineer on site with us during every crew stow operation.
	88	n	yes	
	22	n	yes	Process improvements are being made.
	34	n	no	New paper too detailed which can add to confusion. "CEDAR" system - doesn't feel like he needs to think any more.
	91	n	yes	Yes - but paper needs to provide more latitude with respect to sequence (when sequence does not matter).
53000				
	46	y	no	
	33	y	yes	As long as they don't change anything.
	65	y	yes	

Org Code	Ref#	Supv	Short Resp	Q7 Narrative
	50	y	yes	Yes, but working on improving the work instructions (can be and is being improved).
	21	n	yes	
	44	n	yes	Verbal work instructions, yes - paper work, not so clear.
	83	n	yes	In general - paperwork improving, especially the canned dispos. We know they are trying to make the instructions better - without so many cross-references.
	48	n	yes	
	64	n	yes	
	85	n	yes	Yes, indeed. WADS get better all of the time - books updated and improved.
	67	n	yes	
	52	n	yes	Majority of the time, yes. There are some occasions where the work instructions are not clear - person who wrote it does not know the job/process/system.
	81	n	no	Safety - OK. Operating efficiency - no. Only thing that matters is experience - experience matters more than the paper.
	40	n	yes	
	78	n	yes	"Most of the time."
	90	n	yes	Paper is improving. Moving toward a "boolean" paper approach e.g., "if - then" as opposed to "not perform."
	37	n	yes	
	58	n	yes	New system is better. They are redoing the paperwork.
	71	n	yes	PPICI is really good.
	69	n	yes	"I do and that's because I don't start until I understand the work instructions."
	61	n	yes	"Generally."
	62	n	yes	Mostly (long time in job). Can get things straightened out if needed.
	68	n	yes	
	74	n	yes	
56000				
	80	y	yes	Need more photos and more digital images - design documentation really improving.
	30	y	yes	Does receive clear work instructions - up to first line supervisor, second line supervisor is not clear.
	73	y	yes	
	24	y	yes	

Org Code	Ref#	Supv	Short Resp	Q7 Narrative
	32	n	yes	
	23	n	no	50% of the time paper is sent back to engineering for correction, revision, or clarification. Blames the MAXIMO system. "Sometimes the machine causes a problem with the WAD."
	29	n	no	Clear direction is provided (what needs to be done). Paper is confusing at times - too many steps (MAXIMO system) - too many micro-steps. Parts come in late, sometimes they are wrong.
	35	n	no	No, paper is there but must double check it i.e., call contact.
	25	n	yes	Yes.
	38	n	yes	
	39	n	yes	
	42	n	yes	
	43	n	yes	
	45	n	yes	If there are questions, can readily go to first line supervisor and/or engineering.
	51	n	yes	
	57	n	yes	
	60	n	yes	
	63	n	yes	Briefing before each job. Buddies/teams watch out for each other.
	66	n	yes	Presented with problems to figure out.
	72	n	yes	
	77	n	yes	
	79	n	yes	
	89	n	yes	Yes - pretty much. If we have a question we call engineering. They support us real well.
	56	n	yes	

Question 8: Does your work process(es) have sufficient checks and balances (e.g., inspections) to preclude unsafe operations? If so what are they? If not what would you suggest (e.g., an "extra pair of eyes", an additional inspection point, etc.).

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	67	**93**	5	**7**
Supervisors	12	all	11	**92**	1	**8**
Non-supervisors	60	all	56	**93**	4	**7**
Horizontal Processing (All)	24	51000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**
Vertical Processing (All)	24	53000	24	**100**	0	**0**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		20	**100**	0	**0**
Ground Support (All)	24	56000	22	**92**	2	**8**
Supervisors	4		3	**75**	1	**25**
Non-supervisors	20		19	**95**	1	**5**

Org Code	Ref#	Supv	Short Resp	Q8 Narrative
51000				
	86	y	yes	It has been too much, it has been too thin - it's right right now. Fewer NASA MIPs but more Q-buys right now.
	84	y	yes	Everything we do for flight has USA quality eyes and NASA quality eyes. Non-flight work has tech plus USA quality eyes. There are times when we put a quality inspection back on certain tasks.
	53	y	yes	
	31	y	yes	No, extra "eyes" are necessary.
	47	n	yes	Safety people.
	26	n	yes	"An extra pair of eyes is not fruitful (necessary?)."
	36	n	yes	
	28	n	yes	Writes paper that is reviewed by a second set of eyes. An extra pair of eyes is unnecessary.
	70	n	yes	Generally OK - sometimes overkill - used to have too much NASA.
	59	n	yes	QA and NASA.
	92	n	no	Everyone gets into this "I want to be a hero" operational mode. When things are out of the ordinary people get excited, people get into heroic deed mode. It (checks and balances) is terrible now. Before, we had NASA QC, USA QC checking and monitoring and I would turn wrenches. Now everything is on the tech - QC's have left - tech's job has changed - too much added responsibility. System was much better before. They sure saved a ton of money but it is nowhere as safe now. They should have left well enough alone in the orbiter world.
	54	n	no	No - Have eliminated "extra pair of eyes", i.e. the safety people.
	75	n	yes	Yes, but decreasing trend - reducing payroll results in less safety inspection and less quality on paper. "If we had CDI's might help improve quality - second set of eyes rather than paper."
	76	n	yes	Hazardous activities have QA personnel present (to cover work). Safety/techs verify that safety clearances and warnings are in.
	55	n	yes	
	49	n	yes	Can always go to first line management. Can go straight to Engineering to fix paper problem.
	27	n	yes	Yes, we use the buddy system to check our work. An extra pair of eyes is unnecessary.
	82	n	yes	"Yes - within the group it is good. Initially it was too thin. Now it is pretty good."

Org Code	Ref#	Supv	Short Resp	Q8 Narrative
	41	n	yes	
	87	n	no	We have USA quality. We have NASA quality. They took a lot of quality off the paper. A few more quality inspection points would be beneficial.
	88	n	yes	I think we are OK. A second engineer with similar certifications checks all the paper within the group.
	22	n	yes	Everything that is stowed is quality controlled. If it is Crit-1 hardware NASA quality control also buys-off. An extra set of eyes is unnecessary.
	34	n	yes	Yes, for checks and balances. No, for an extra pair of "eyes."
	91	n	yes	However, there is too much inspection in the TPS area. 50 inspection points to service and replace a single tile - including witness and verification steps - need a QC for each. Ties hands too much.
53000				
	46	y	yes	Second and third set of "eyes" with contractor and NASA quality personnel.
	33	y	yes	Extra pair of "eyes", no.
	65	y	yes	Two NASA inspectors.
	50	y	yes	
	21	n	yes	Tech's do hands on inspection (quality review). The pyro work receives 100% engineering inspection.
	44	n	yes	Extra pair of "eyes" would be valuable.
	83	n	yes	Yes - it is OK right now. Originally they took off too much inspection but now it has been restored.
	48	n	yes	
	64	n	yes	Extra set of eyes with team system (up to 4).
	85	n	yes	"Pretty much - very few quality points in the LOX processes. We use a two person team discipline normally. During launch ops we have a two person team plus engineering to check the work." "Very little interface with NASA quality or USA quality has speeded things up without loss of quality."
	67	n	yes	QA Staff inspections - USA and NASA.
	52	n	yes	Yes, plenty of checks and balances.
	81	n	yes	Yes, I have to admit. It used to be overkill. We have an extra set of eyes when we need it. Three sets of eyes essential for any close-out activity.
	40	n	yes	Not applicable
	78	n	yes	More than average workplace in the US.
	90	n	yes	Engineering group cross-checks all dispositions (self-check) within group. Techs and engineers have strong positive working relationship.

Org Code	Ref#	Supv	Short Resp	Q8 Narrative
	37	n	yes	Yes, on checks and balances - no, for extra pair of "eyes."
	58	n	yes	Tech in charge. Visuals. Hands-on. NASA and USA QA. Everyone watches out for the other person - good team concepts.
	71	n	yes	Without a doubt - plenty of quality inspection points throughout our books. Checks and balances (USA and NASA) are just about right.
	69	n	yes	Things have changed somewhat - if something is flight critical we have worker + tech buy + UAS/Q + NASA/Q. If something is non-critical just worker + tech buy.
	61	n	yes	First line managers on floor and lead techs. Task team leaders check tasks. Trainees are teamed with experienced technicians.
	62	n	yes	TQWN - Tech/Quality/Witness/NASA Quality.
	68	n	yes	For the most part experienced staff have knowledge. Newer staff may lack knowledge, sent on jobs with paperwork only - could be a problem. Newer staff should be paired with experienced staff, but doesn't always happen. Poor judgement with respect to schedule.
	74	n	yes	Examples: - document laid out, - summary of hazards, - pre-task briefings, - walk down work area issues.
56000				
	80	y	no	We are limited in manpower. We don't have checks and balances - facility power group may not need as much. Self checking: - shop supervisor is check number 1, - field technician is check number 2.
	30	y	yes	
	73	y	yes	Quality and safety surveillance. Engineer on site runs tests/maintenance.
	24	y	yes	We have a buddy system support approach to checking our own work. An extra pair of "eyes" is unnecessary.
	32	n	yes	However, extra pairs of "eyes" would be beneficial to overall safety.
	23	n	yes	Prior to launch, valve positioning is verified by QC. Filter changes, gauge calibration, regulator checkout, are QC witnessed at times. We work as a team. An extra pair of "eyes" is unnecessary.

Org Code	Ref#	Supv	Short Resp	Q8 Narrative
	29	n	no	"Put the safety guy back on the job. Safety has been transferred to the worker."
	35	n	yes	Monthly/yearly inspections on cranes.
	25	n	yes	"Inspections are done by qualified people." An extra pair of eyes would not be beneficial.
	38	n	yes	Extra pair of "eyes" of no value - on the RSS observers are on every level and preventive maintenance work is verified by engineering.
	39	n	yes	Yes, checks and balances. Extra pair of "eyes" is no significant value to safety.
	42	n	yes	
	43	n	yes	
	45	n	yes	Buddy system. Lock out/tag out. There is a "culture of safety."
	51	n	yes	Yes, lots of checks and balances. Walk down crane before every operation. Pre-shift and pre-ops safety briefings.
	57	n	yes	Inspections. Corporate memory. Safety specialists. Staff watches out for each other.
	60	n	yes	Buddy system - one oversees the other.
	63	n	yes	Riggings may be with temporary railings. Supposed to brief everybody before they do a job. Each person has his own point of view. Each group has its own lead responsible for paper work. Have to get your own equipment to do your own work. In terms of inspections, they look at things themselves and no one has ever questioned their work.
	66	n	yes	Inspectors.
	72	n	yes	The first part of every work instruction contains safety information.
	77	n	yes	Written procedures (metrics embedded). Check lists. Problems sent to engineering. Inspections (frequent).
	79	n	yes	

Org Code	Ref#	Supv	Short Resp	Q8 Narrative
	89	n	yes	We use a buddy system as a backup. Two people in the cab at all times. We also have: - supervisory lead, - emergency stop, - ground control, - backup personnel, plus - NASA Q and USA Q plus structured surveillance (but I don't know what they do).
	56	n	yes	Walk downs. Orbiter weather protection move.

Question 9: Do you feel it's OK to call a "timeout" when you see safety violations or unsafe behaviors without fear of adverse action? (Is the policy clearly defined? Is it clear to you when to use it?)

Summary of Results	n	Org Code	# Yes	% Yes	# No	% No
Overall	72	all	67	**93**	5	**7**
Supervisors	12	all	12	**100**	0	**0**
Non-supervisors	60	all	55	**92**	5	**8**
Horizontal Processing (All)	24	51000	21	**88**	3	**12**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		17	**85**	3	**15**
Vertical Processing (All)	24	53000	23	**96**	1	**4**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**
Ground Support (All)	24	56000	23	**96**	1	**5**
Supervisors	4		4	**100**	0	**0**
Non-supervisors	20		19	**95**	1	**5**

Org Code	Ref#	Supv	Short Resp	Q9 Narrative
51000				
	86	y	yes	Yes - that is a given - management repeatedly reinforces this. Safety Days, timeouts, Dupont, all matter - Bridges and King walkaround also very, very important.
	84	y	yes	I insist on it! Everyone understands it. Top three reasons for timeout are: 1) don't understand the paper, 2) some potential safety issue not captured in the paper, 3) if you are tired and confused - less than 100%.
	53	y	yes	Absolutely! "Is the policy clearly defined ?" - No!
	31	y	yes	Excellent job of making people aware that it is a good thing.
	47	n	yes	Absolutely.
	26	n	yes	Yes, time outs are mandatory and supervisors are supportive of timeouts.
	36	n	no	Most of the time. Flight test aircraft costs $13k/hr to operate. Less inclined to call time out.
	28	n	yes	Yes, absolutely.
	70	n	yes	"They pretty much drill that into you." Provided example: "We were hearing clicks and noises so we stopped." Crew obviously uses the familiar sound of normal operation as a check.
	59	n	no	"Does not feel it is ok to call TO all the time you see a safety violation." Not in your best career interest to call TO's. Policy is clear and clear when to use it.
	92	n	no	It depends on the job. No one would call timeout if you are only tired. You do it for potential danger any time, any place.
	54	n	yes	
	75	n	yes	Feel's that it is mandatory - does not fear adverse action
	76	n	yes	
	55	n	yes	Definitely!
	49	n	yes	Absolutely!
	27	n	yes	Yes, absolutely.
	82	n	yes	Absolutely, a very valuable tool - and I have done it. Given the crunch of trying to meet the workload with not enough people it is an important safety process.
	41	n	yes	Somewhat, if it comes down to "crunch time", i.e., roll-out.

Org Code	Ref#	Supv	Short Resp	Q9 Narrative
	87	n	yes	Yes we use it when: - we need clarification we call timeout, - we are stressed out or fatigued.
	88	n	yes	Absolutely - you don't need to stand up and call out timeout -. you can quietly, in an engineering sense stop and talk about it. The message is passed on to the new guys to call time out.
	22	n	yes	
	34	n	yes	
	91	n	yes	Sure, it's crazy not to. Call time out if safety issue or need to clarify paper.
53000				
	46	y	yes	To a point, but resolution of "time out" is problematic. Don't always do the "right" thing but what is "politically correct" or convenient.
	33	y	yes	Encourages as well as his co-manager.
	65	y	yes	
	50	y	yes	Yes, with a capital "Y."
	21	n	yes	I encourage calling time-out.
	44	n	yes	Absolutely.
	83	n	yes	Absolutely - no problem. I will call timeout anytime we need it. "If it ain't right, I'm not doin' it."
	48	n	yes	Opinions between touch-labor work force and engineering may be different.
	64	n	yes	
	85	n	yes	Without a doubt - everyone knows that. Upper management reinforces this all the time.
	67	n	yes	
	52	n	yes	Definitely!
	81	n	no	Yes, absolutely and I have gotten into trouble for doing it. They look at you funny. Pad and VAB is more accepting of timeout. Horizontal is less accepting of timeout.
	40	n	yes	Absolutely!
	78	n	yes	Supervisors encourage it.
	90	n	yes	Yes, I just say let's stop and review where we are. Let's hold up.
	37	n	yes	Encouraged to call TO when necessary.
	58	n	yes	Knows when to call it, clear when to use it.
	71	n	yes	"I would not hesitate one moment to call a time out." Examples given: "If the paper was not right I would call Engineering." "There is always a safety message given by managers, supervisors, and flow managers." They always stress the point to call time out. Years ago people frowned on calling time out. Things have really changed a lot. There is a mutual respect for time out.

Org Code	Ref#	Supv	Short Resp	Q9 Narrative
	69	n	yes	"It's a good system. If something is not going right pull back and take a time out - If something doesn't feel right, if a problem exists with the paperwork, if the right people are not present, if a change has been made to the paper."
	61	n	yes	yes/yes/yes.
	62	n	yes	Yes, when not feeling comfortable. Yes, ("Is the policy clearly defined?"). Yes, ("Is it clear when to use it?").
	68	n	yes	
	74	n	yes	There is some question about when to resume work and who has authority to press on. (Who is decision official? How is issue dispositioned?)
56000				
	80	y	yes	Time out is a great process.
	30	y	yes	Has no trouble calling a time out, however other groups are not always happy (pad managers, OPF cite coordinators, Shuttle test managers).
	73	y	yes	Briefed as observers to call TO for maintenance/operations/testing. Save lives/not damage launch equipment. Buddy system works well.
	24	y	yes	Yes, most definitely.
	32	n	yes	Generally supported by management but some don't support the call.
	23	n	yes	Yes - very comfortable. I have called time out when I did not understand a procedure.
	29	n	no	It is getting better, some supervisors have a problem with it - the culture is moving slowly.
	35	n	yes	But management may not like it during launch operations.
	25	n	yes	Yes, supervisors are very supportive.
	38	n	yes	
	39	n	yes	Supervisors are supportive.
	42	n	yes	Absolutely.
	43	n	yes	
	45	n	yes	
	51	n	yes	Definitely!
	57	n	yes	Cautionary notes: - there are attitudes and concerns that you might be slowing down process. - need to be sure and willing to back the stoppage. - some want to just get the job done.
	60	n	yes	Yes, clearly defined. Yes, knows when to use it.
	63	n	yes	

Org Code	Ref#	Supv	Short Resp	Q9 Narrative
	66	n	yes	
	72	n	yes	Definitely - take it to the lead man or the supervisor. USA is by far the safest place he has worked in 21 years as a machinist. "A very safe operation." Call timeout if something is unclear, illegible, problem with tooling, something not right, something doesn't add-up.
	77	n	yes	Definitely.
	79	n	yes	"A very good thing."
	89	n	yes	Very important. "You can always explain why you called a timeout. You cannot explain why you didn't."
	56	n	yes	No fear of adverse action - policy clearly defined.

Question 10: Are there things or conditions in other areas that you know about that are unsafe or could lead to an unsafe condition?

Org Code	Ref#	Supv	Q10 Narrative
51000			
	86	y	None.
	84	y	
	53	y	
	31	y	No strong feelings.
	47	n	Don't generally see other areas.
	26	n	
	36	n	
	28	n	
	70	n	Change the way the Palm people look at their jobs. Talk with people.
	59	n	Pad ops with union workers on pad hanging with no safety belts - informed pad managers.
	92	n	
	54	n	
	75	n	
	76	n	
	55	n	Increase preventive maintenance in GSE - need more manpower to support - sufficient in the past but reductions have been instituted.
	49	n	
	27	n	No.
	82	n	
	41	n	
	87	n	
	88	n	Nothing I would keep to myself. You would want to use the risk RATS system if you had an issue.
	22	n	
	34	n	Star tracker door should have a hoisted system for removal and installation.
	91	n	None.
53000			
	46	y	Not really.

Org Code	Ref#	Supv	Q10 Narrative
	33	y	Pad facility maintenance group (GSS) do not appear to follow same safety discipline/roles they should and that others are following. Two recent examples: 1) Untethered wrench (with Orbiter on the pad) at level 195 of the FSS - fell to level 120, 2) Tech was installing a clamp on a water line of the Fire X system (level 208) of the ETIT line without a safety harness.
	65	y	
	50	y	
	21	n	
	44	n	None that I know of.
	83	n	None.
	48	n	"Facilities" using any safety rope they can find. "Hyper Shop" rope used by somebody else without their knowledge.
	64	n	
	85	n	None.
	67	n	
	52	n	
	81	n	
	40	n	
	78	n	
	90	n	None.
	37	n	During launch ops we go to a two shift operation with the day shift starting at 3AM and completing at 3PM. The 3AM start time is hard on people. People are still in a state of sleep and not a t peak performance. Suggest a later start time for this shift (safety issue).
	58	n	No.
	71	n	Need to look more at facilities, in particular structures like the pads.
	69	n	You can get stress just sitting around. You can get stress with nothing to do. I like it when we have four vehicles in flow. I see it as a plus because it keeps us busy.
	61	n	No.
	62	n	
	68	n	
	74	n	When short staffed - borrow people from other areas - those individuals lack knowledge and are not pre-briefed.
56000			
	80	y	NASA facilities engineering - lots of people doing stuff that is unnecessary.
	30	y	As a manager, it is very unfair that she is being forced to forego overtime while observing other groups who are allowed to work excessive OT.
	73	y	

Org Code	Ref#	Supv	Q10 Narrative
	24	y	No, however if it was observed it would be brought to the attention of the appropriate people. The employee does not feel that it is necessary to have verification by QC for welding operations that occur on the crawler. The employee expressed concerns that electronic technicians are doing jobs that should be done by electrical technicians.
	32	n	While working in the OPF with hazardous operations/venting hypergols occur while he is performing a lifting operation.
	23	n	
	29	n	Recently encountered an individual who made a mistake during a hazardous booster operation. When asked to follow the book the employee indicated that he "didn't need to review the book." Work scheduling is a serious concern. Often finds himself sitting idle, creating stress. Blames schedulers for calling him to a work station knowing full well that the work will not begin on time. They do this because there are too few crane operators.
	35	n	Other people doing everybody else's work.
	25	n	Haven't had time to notice.
	38	n	
	39	n	Previously worked in the orbiter ECLSS area. When working in the mid-body area, limited protection of flight hardware tubing and damage potential is very high.
	42	n	Not that I know of.
	43	n	Not that I can think of.
	45	n	Electricians (power) versus electronic technicians (control) - Clearly define differences between control and power functions and have appropriate people perform those functions, i.e., do not mix functions.
	51	n	
	57	n	Getting rushed and hurried in all areas around launch time.
	60	n	NASA and contractors have let a lot of people go depleting corporate memory. Not enough staff. Not all OT is by choice - sometimes you have to just meet the external schedule.
	63	n	None that he knows of - if he runs into a small problem, he can speak to the safety people and they take care of it.
	66	n	Normally taken care of (real time) when they see a problem.
	72	n	No. "Safety is in your face - safety is something you cannot consciously ignore."
	77	n	
	79	n	
	89	n	Buzzards get in the building, become trapped, die, and decay creating a noxious work environment. This is a distraction.
	56	n	No.

Question 11: Indicate your current average level of workplace-induced stress using a scale of one to five where one indicates no stress, two indicates low stress, three indicates a neutral response, four indicates moderate stress, and five indicates high stress.

Org Code	Ref#	Supv	Stress Level	Q11 Narrative
51000				
	86	y	3.5	Overall 3.5 with peaks and valleys. Roll-in and roll-out (of OPF or VAB) milestones create stress. 4-5 flights per year is no sweat.
	84	y	3	Personal stress level is 3. Speculation (his opinion) that: Off-line crews or people in labs is probably 2.0. Flight line crews and critical path activity is 4.0 (requires a lot of work time deviations). Four in-flow introduces the need to thin out manpower. Four-in flow is just above the comfortable stress level
	53	y	4	Lack of manpower - running so lean there is no chance if something goes wrong.
	31	y	4	
	47	n	3	
	26	n	2	
	36	n	4	People trying to manipulate the situation/other people in the department. Tension between young and old workforce: - no consideration for seniority, - lack of people orientation, job orientation only. Overseas operations - better to work 7 days a week than 5 on and 2 off.
	28	n	3.5	Normally between three and four, but it can peak to five.
	70	n	2	
	59	n	4	Stress is 1 during normal ops - 5 when compressed (4 is IAT judgement call). Need cutoff time for changes. Need more staff - get from other teams as needed. Do not have staffing to support more than six flights per year. Changes are not a bother if they fit into schedule. When schedule content is excessive, when pressure is on we make mistakes even during normal work hours.
	92	n	3	When I was in the OPF it was always a 5. Right now it is a 3. Believes that 8 to 10 flights per year is possible if more quality inspectors were added.
	54	n	3.5	Varies on a daily basis. Reduce stress level by minimizing "starts" and "stops."
	75	n	1	

Org Code	Ref#	Supv	Stress Level	Q11 Narrative
	76	n	3	With more OT vacations becomes an issue. Near launch stress increases (suggests an understaffing issue). Attrition issues exist in organization - people leaving and not replaced. In six months lost 35 years of experience (14 to 18 year veterans) and replaced with entry level individuals. Really a problem given the lead time to achieve certification. Observations: - range safety engineering borrowed to support launch, - borrowed GNC engineering to support launch, - 3 years certification process for communication engineering job, - 3 s-band certs.
	55	n	3	
	49	n	2.5	Average (3) - for on-schedule flows. Low (2) - on a daily basis.
	27	n	4	Self-inflicted - good stress.
	82	n	4.5	"We are on the edge - for my group we are only one deep." "We have many single point failures." Real dicey now - need more people who are trained. We have some L1s, no L2s, and lots of L3s. "Six flights is going to be tough - we are too thin." "We are stretching the rubber band - we are on the line right now - we are backing off." "It doesn't matter what flow wants (breaking 12 hour rule)." Stress level of 4.5 relates to workload and schedule pressure.
	41	n	4	
	87	n	3.5	Stress is 3.5 on average, but 4.5 during critical stows. Stress is 5 with late arriving JSC direction and hardware. With four-in-flow, we are on the line of safety. Change/change/change creates high stress. Houston ships stuff to meet a milestone date but kits are incomplete. This screws up the Crew Equipment and Integration test sequences. JSC engineering makes so many late changes to paper, hardware, and drawings it creates lots of stress. Cargo mechanical engineering is hard to find around here - lots are too young and don't know their jobs - no experience. Curtail the tours (of the white room) when critical operations are underway - tourists are a real problem when we are pushed.
	88	n	3	Personal stress level is 3.0. Feels that the work group stress level is 4.0 with all of the personnel changes. The stress is in our Level 1 personnel. We have a lot of sharp young people but it takes five to six years to get up to Level 1 proficiency. From his work group standpoint he feels that six to seven flights per year is OK. He notes that eight clean vehicle flows are easier than six or seven with problems.

Org Code	Ref#	Supv	Stress Level	Q11 Narrative
	22	n	2.5	
	34	n	4	Given work flow schedule and manifest. Insufficient numbers of trained personnel.
	91	n	2	Stress examples include: - doing the additional safety job adds stress, - remote test operations introduces failure modes, - shared Bay-1/Bay-2 scrubbers creates problems. Three-in-flow cannot be supported (much less four-in-flow) without lots of juggling. Current OT is going to wear people out. Sustainable only for spurts. Six evenly spaced flights is sustainable.
53000				
	46	y	2	Process is safe.
	33	y	4	Dealing with hazardous commodities. If the flight rate exceeded six per year, stress level would increase.
	65	y	1	
	50	y	3	The scheduling of flows affects stress level, i.e., spreading flows out over time available would lower stress level. Avoid two at a time (high work load/high overtime) on the pad. For example: - 6 flows/yr. - 1 flow every 1 to 2 months, not 5 flows in 2 months, - 8 flows/yr. - this would result in 2 or 3 times in that year where you would have "two at a time on the pad." Four-in-flow will test process in place. 1st shift is a "bear," 2nd shift is "easy" - "check the parking lot."
	21	n	3.5	Three to four most of the time (80-% of the time). Occasionally it goes to a five (20% of the time).
	44	n	3	SRB - level of 4. Orbiter - level of 2. Transferred out of SRB to Orbiter - was much more stressed out in SRB operations. Orbiter operations has good team work.
	83	n	3	My steady state stress is 3.0. On launch day stress is 7.5! - isolated high stress events occur.
	48	n	2	Easier to do straight 12 hrs than one day on, one day off.
	64	n	1	OT sporadic - less than 40 hrs/year.
	85	n	1	The current flight rate is too low. Our team could handle 12 per year, one every two months on each pad.

Org Code	Ref#	Supv	Stress Level	Q11 Narrative
	67	n	1	Choice for OT, can say no. He takes it to get extra pay. 60hrs/wk limit OK - never asked to work over 12hrs. Can do this 1-2 weeks. Conditions here (USA) good - a lot easier than on the outside of NASA. Pay benefits much better here (USA).
	52	n	4	Major problem is communications among the shops, engineering, etc. Improve communications. Older work force less responsive to direction -older work force becomes entrenched. "Wish we had new people/new blood."
	81	n	3	Allowing schedulers to tell supervisors what to do is unsafe, especially on first shift. You really see schedule push. All new guys are on first shift - all older, experienced guys are on second shift. Not enough people on second shift. Skill mix is wrong on first shift. Shift rotation needs improvement: - even out shifts, train people, - get better training on second shift. Six flights is safe for current staffing levels. Supervisors need to have experience as a technician or quality inspector. Some supervisors don't know the paper or the work. (Questions the need for supervisor to have a four year degree.) PAD stress is 2.0. OPF stress is 4.0 (indoor dungeon). Average stress taken to be 3.0.
	40	n	2	
	78	n	1	Need a hard look at needing more safety professionals. Prefer more OT.
	90	n	2	Stress =2. Has fun, enjoys people he works with. Current safe flight rate? Six per year is OK - seven might get tight. We spend a lot of time doing logistics work. If parts are not available we have to research parts and reorder - a continuing problem.
	37	n	2	Stress level is normally 2 but can go to 4 to 5 during launch.
	58	n	1.5	Great management - no complaints. Four 12 hour days straight in VAB, fifth day is 8 hours - his shift, his choice.
	71	n	2	"A steady flow rate is safer - four in-flow is no problem." "People cooperate better with steady work."
	69	n	3	Right now stress is at a 2. When a vehicle is in the VAB it goes to a 4.0 but that is "motivational stress - a good kind of stress." (Value of 3.0 entered based on comments.)

Org Code	Ref#	Supv	Stress Level	Q11 Narrative
	61	n	3.5	Jobs come from nowhere (OPF) - paper comes - 2-3 hours to figure out paper - stuff half done - has to call OPF techs. Sudden appearance of unplanned work plus having to maintain schedule causes stress. He does like OT - when orbiter comes to pad OT could be three to four weeks in a row.
	62	n	2	Certain types of people do well with certain types of overlaps in shifts. Medium pace is OK. Three days of 12 hr shifts is OK but 4 or 5 days is tough. Staying over is easier than coming in early. 60 hr max without waiver is current limit - going to 70 hr waiver would make the workers too tired.
	68	n	2	None.
	74	n	1	No comment.
56000				
	80	y	5	Higher flight rate is a blessing. Flight rate does not drive stress - starting and stopping drives stress. Self-assessment of stress related to: - personnel changeover, - lack of faith in first line manager to do the job right, - lack of empowerment.
	30	y	5	
	73	y	1	
	24	y	3	Routinely a two, but during crawler operations it can go to a five. Gives himself a three.
	32	n	2	Overtime adds no stress.
	23	n	1	
	29	n	3	Gives himself a two to a five, but five not very often.
	35	n	2	
	25	n	1	No elaboration.
	38	n	2	Safety is paramount and applied liberally.
	39	n	3	Level 3, generally. Goes to level 5 when trying to get parts.
	42	n	2	
	43	n	2	Scheduling changes adds to stress levels - waiting for other operations to complete before being able to complete your operations.
	45	n	1	No correlation between stress and workload if paper, controls, etc. are in place (likes to be busy, prefers high work load).

Org Code Ref#	Supv	Stress Level	Q11 Narrative
51	n	1	None (1) - personally. Experience is a factor - working overtime does not necessarily up the stress level. "Official training" takes 6 months to gain all required certifications however it really takes a minimum of 1 year to train crane operator. Do not have sufficient manpower in the pipeline to replace trained crane operators. Department needs increased recognition.
57	n	2	Works OT by choice - likes working OT. Needs more staff
60	n	2	Likes his job - likes working OT. They should correct the crummy USA retirement system - people work OT to save for retirement because the package is so bad.
63	n	1	
66	n	1	Could do 60 hrs/ wk easily - 70 hrs/wk would be a lot of help, everyone use to it. (Now doing ~50hrs/wk, 1 year with USA) OT is necessary for amount of work they have to do to do it safely - more staff might not change OT requirements.
72	n	2	OT is never forced - likes OT. Does weekend work supporting LM Atlas operations.
77	n	2	Every launch does damage to MLP. Everything should be loaded back into logistics parts inventory for major use parts.
79	n	2	Low stress - no flight rate induced stress. Happy to have a job with NASA. General comments: - meetings every week - people focused on safety - crew take good care of each other - "they teach you - they certify you - if you don't have certs you can't get on nothing"
89	n	3	Six (flight rate) per year is fine. Maybe 7 or 8 is OK, at least in our area. We need one to two years to train new people. This is a challenge because we are lifting flight hardware there is zero margin for error.
56	n	1	Needs more staff Eliminate second and third shift, just cover with OT.

Work Time Deviations and Self-Assessed Stress Level

Org Code	Ref#	Sup?	Stress	#WTD	>12h/d	>16h/cont	<8h-off/sft	>7d cont	>60h/w	>240/28d
51000										
	86	y	3.5	0	0	0	0	0	0	0
	84	y	3	0	0	0	0	0	0	0
	53	y	4	0	0	0	0	0	0	0
	31	y	4	0	0	0	0	0	0	0
	47	n	3	3	2	0	0	1	0	0
	26	n	2	2	0	0	0	2	0	0
	36	n	4	1	0	0	0	1	0	0
	28	n	3.5	1	1	0	0	0	0	0
	70	n	2	2	1	0	0	1	0	0
	59	n	4	3	0	0	0	3	0	0
	92	n	3	1	1	0	0	0	0	0
	54	n	3.5	1	1	0	0	0	0	0
	75	n	1	4	2	0	0	1	1	0
	76	n	3	1	0	0	0	1	0	0
	55	n	3	1	0	0	0	1	0	0
	49	n	2.5	2	1	0	0	1	0	0
	27	n	4	3	0	1	0	1	1	0
	82	n	4.5	2	2	0	0	0	0	0
	41	n	4	1	0	0	0	1	0	0
	87	n	3.5	2	0	0	0	2	0	0
	88	n	3	1	0	0	0	1	0	0
	22	n	2.5	2	0	0	0	2	0	0
	34	n	4	1	0	0	0	1	0	0
	91	n	2	1	0	0	0	1	0	0
53000										
	46	y	2	4	0	0	0	2	2	0
	33	y	4	0	0	0	0	0	0	0
	65	y	1	0	0	0	0	0	0	0
	50	y	3	1	0	0	0	0	1	0
	21	n	3.5	1	0	0	0	1	0	0
	44	n	3	4	0	0	0	2	2	0
	83	n	3	1	0	0	0	1	0	0
	48	n	2	3	1	0	0	1	1	0
	64	n	1	5	3	0	0	1	1	0
	85	n	1	1	0	0	0	1	0	0
	67	n	1	4	0	0	0	2	2	0
	52	n	4	1	0	0	0	1	0	0
	81	n	3	4	1	0	0	2	1	0
	40	n	2	1	0	0	0	1	0	0
	78	n	1	1	0	0	0	1	0	0
	90	n	2	1	1	0	0	0	0	0
	37	n	2	1	0	0	0	1	0	0
	58	n	1.5	4	0	0	0	2	2	0
	71	n	2	1	0	0	0	1	0	0
	69	n	3	4	0	0	0	2	2	0

Org Code	Ref#	Supv	Stress	#WTD	>12h/d	>16h/cont	<8h-off/sft	>7d cont	>60h/w	>240/28d
	61	n	3.5	1	0	0	0	1	0	0
	62	n	2	5	0	0	0	3	2	0
	68	n	2	1	0	0	0	1	0	0
	74	n	1	1	0	0	0	1	0	0
56000										
	80	y	5	3	1	0	0	1	1	0
	30	y	5	3	2	0	0	0	1	0
	73	y	1	5	4	0	0	0	1	0
	24	y	3	4	4	0	0	0	0	0
	32	n	2	7	3	0	0	2	2	0
	23	n	1	1	1	0	0	0	0	0
	29	n	3	9	5	0	0	2	2	0
	35	n	2	1	1	0	0	0	0	0
	25	n	1	8	4	0	0	0	4	0
	38	n	2	11	12	0	0	0	3	0
	39	n	3	1	1	0	0	0	0	0
	42	n	2	1	0	0	0	0	1	0
	43	n	2	1	1	0	0	0	0	0
	45	n	1	1	1	0	0	0	0	0
	51	n	1	12	2	0	0	6	4	0
	57	n	2	10	8	0	0	0	2	0
	60	n	2	7	1	0	0	2	4	0
	63	n	1	1	0	0	0	1	0	0
	66	n	1	7	5	0	0	0	2	0
	72	n	2	1	0	0	0	1	0	0
	77	n	2	1	0	0	0	0	1	0
	79	n	2	9	6	0	0	0	3	0
	89	n	3	8	1	0	0	4	3	0
	56	n	1	11	8	0	0	0	3	0

Appendix D - Large Sample Test of Hypothesis

Difference Between Two Population Means
for
Self-Assessed Stress Level

1) Null Hypothesis

H_o: $\mu_H = \mu_L$

H → High Work Time Deviation (WTD) Sample
L → Low Work Time Deviation Sample

2) Alternative Hypothesis

H_a: $\mu_H \neq \mu_L$ (Two-Tailed Test)

3) Test Statistic

$$Z = \frac{\bar{x}_H - \bar{x}_L}{\sqrt{\frac{s_H^2}{n_H} + \frac{s_L^2}{n_L}}} = \frac{1.89 - 2.77}{\sqrt{\frac{0.82}{22} + \frac{1.11}{50}}} = -3.61$$

4) Rejection Region

$Z > Z_{\alpha/2}$ or $Z < -Z_{\alpha/2}$ (Two-Tailed Test)

For a = 0.05 (or confidence coefficient of 0.95)

$Z_{\alpha/2} = Z_{.025} = 1.96$

and since $Z < -Z_{\alpha/2}$ or $-3.61 < -1.96$,

Reject the Null Hypothesis, i.e., there is a statistically significant difference between the High WTD and Low WTD populations for self-assessed stress level.